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CONTENTS.


EDITORIAL:
Competition of High-Pressure Gas....1067
Storage on Southern Streams....1068
Increase of Flaming Arcs at Boston....1069
Chicago Arranging for Complete Electric Lighting of Its Streets....1070
Wisconsin Electrical Association....1070
National Electric Light Association to Investigate Terminology....1070
Ohio Society of Mechanical, Electrical and Steam Engineers....1070
American Association of Electric Motor Manufacturers....1071
Removing Cancer by Electricity....1071
Transmitting Pictures Across the Atlantic....1071
Reducing Smoke in the "Black Country" in England....1071
Chicago Electric Club....1072
The Big Independent Telephone Convention....1072
Alabama Light and Traction Association....1072
The Determination of the Circle Coefficient of the Induction Motor....1073
A European Electric Train-Lighting System....1076
Diplomacy in Business....1077
The Value of Mathematics....1077
The Rougé-Faget Permutator....1078
A New Mercury Interrupter....1081
Street Telephone Stations on Poles....1081
Laws of Electrode Losses in Electric Furnaces....1082
Electric Smelting Costs in Sweden....1084
Cadmium Amalgams and the Weston Normal Cell....1085
ELECTRIC TRACTION:
A Modern Electric-Railway Substation....1086
Three-Phase Traction Systems....1087
Device for Preventing Collisions....1088
Increased Earnings of Wisconsin Railways....1088
CENTRAL-STATION PRACTICE:
Notes on Long-Distance Transmission....1089
Waterhammer and Steam Explosion....1090
A New Australian Central Station....1091
Waterpower in Iceland....1091
An International Congress of Radiology and Electricity....1091
TELEGRAPHY—TELEPHONY AND WIRELESS:
Automanual Telephone Exchange at Ashtabula, Ohio....1092
Neon and Electric Waves....1095
New Ruling on Telephone Installation....1095
INDUSTRIAL POWER:
Speed Control of Electric Motors....1096
Electric Developments in Birmingham, England....1097
BOOK REVIEWS....1098
FINANCIAL REPORTS OF ELECTRICAL COMPANIES....1099
INDUSTRIAL SECTION:
Installation of an Intercommunicating Telephone System in a Jewelry Manufacturing Plant....1100
Combined Disconnecting and Transfer Switch....1101
A Fire and a Quick Installation....1101
Arc Lamps for Various Phases of Illumination....1102
Allis-Chalmers Sales of Pumping Machinery....1102
What Constitutes a Good Lubricant?....1103
Central Electric Exhibit at Illinois State Convention....1103
Electrically-Heated Devices for Holiday Trade....1104
Underground Transformers....1104
Electrical Equipment for a Large Shop....1104
CURRENT ELECTRICAL NEWS....1105
RECORD OF ELECTRICAL PATENTS....1112


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## COMPETITION OF HIGH-PRESSURE GAS.

While electrical supply systems are rapidly spreading over wider areas with the aid of high voltages, similar results on a smaller scale are being reached with gas.

One result of this is to increase the competition of gas with electricity in small places where the manufacture of gas in local plants is relatively expensive. It is in the towns that electric lighting has ever had its greatest advantage over gas, and it will be found that to maintain this advantage it will be more and more necessary to displace the small generating stations with transmitted energy from large systems.

As long as the policy of merging the small electric plants into the large generating and transmission systems is followed, there need be no fear that the electric light will not hold its advantage over even high-pressure gas.

The adoption of high-pressure gas for the supply in small places is due to the desire to reduce costs by production on a large scale and at points where low rates can be had for the transportation of materials. On this point it may be said that large-scale production is decidedly more essential to low costs in gas than in electric works. While the gas interests have thus much to gain by the concentration of production, they must pay a greater price for the distribution of the product.

A rough comparison may be made between the pressures of two, three or four inches of water at which many large gas plants distribute their product, and the 250-volt, three-wire system of electrical supply, as far as ability to cover wide areas and long distances is concerned. It is thus out of the question for these large, low-pressure gas plants to supply towns even a few miles distant by simply extending the regular distributing system. The other alternative is to compress the gas to five, ten, twenty or more pounds per square inch, according to the length of the transmission and other factors, and then to reduce the pressure at the place of use.

Where the gas must be compressed the extra cost begins. For the compression there must be provided machinery driven by electric motors, engines or waterwheels, and the first cost and operating expenses for such machinery are decidedly higher than the corresponding cost and expenses of transformers in an electric system. By compressing the gas the sizes of pipes necessary to convey it are greatly reduced, but these pipes must be of extra strength and have especially tight joints. The most expensive feature of the pipe system usually is the great length that must be laid to sell a given volume of gas annually.

Having transmitted the gas to its points of use, the pressure must be reduced before consumption can begin. Two methods are in vogue to achieve this result, one being to connect the high-pressure gas main with a local, low-pressure distributing system through regulators that reduce the pressure to about the usual two or three inches of water. The other method is to distribute entirely with high-pressure mains, and to connect each meter with these mains through a service governor that gives any desired pressure at that particular meter only.

Against the greater economy of gas production at favorable points on a large scale, there must be a large investment in mains, governors and services to deliver the gas to consumers.

An illustration of the importance of the items last mentioned may be taken from a recent estimate of the cost of construction for a new gas plant to supply 8,000 consumers on the high-pressure system. This plant is to have its works for the manufacture of gas on a water front so as to get cheap transportation, and is intended to reach some ten towns within a radius of about twelve miles. To reach the 8,000 consumers in these towns it was estimated that 100 miles of high-pressure mains from two to six inches in diameter would have to be laid at a cost of $583,240, including the services and governors.

In this instance all of the mains are to operate at high pressure, and the meter of each consumer will be connected through a service governor. The cost just stated for mains, services and governors alone amounts to $5,832 per mile of line, and to $73 per prospective consumer, and these figures may be compared with the cost of 100 miles of electric line within a radius of twelve miles to connect with 8,000 consumers.

Gas of eighteen to twenty candlepower is to be sold by the above system at $1.00 per thousand feet, while gas of this quality would ordinarily sell for as much as $1.50 per thousand feet in towns of 3,000 to 11,000 population each, like the above, if made in local plants. It is evident that while the electrical supply system of a large city would have little to fear from dollar gas if extended to the above towns, small, local electric stations might find it inconvenient to meet the competition. One of the towns where a franchise for the above gas system is sought hesitates to let the cheap gas come in, because the town has a municipal electric plant. Of course a private electric corporation could expect no such mercy as the exclusion of low-priced gas, and hence the bearing of the above suggestions as to the extension of large electrical systems to the small towns.

The practice of transmitting compressed gas to small places has grown up mainly during the past ten years, and is now on the increase. In a state whose records are at hand compressed gas is sent to nine towns from four manufacturing plants. One plant in Illinois is reported to have more than 4,000 consumers supplied with high-pressure gas in several towns; a plant in Indiana has more than 4,000; and one in California has more than 5,000 such consumers.

All this goes to show that the gas companies are not slow to grasp to the smallest extent possible the advantages of transmission over a wide area from a large generating plant.

## STORAGE ON SOUTHERN STREAMS.

Between the Potomac and the Mississippi the South is traversed by many large and powerful rivers, such as the James, of Virginia, the Catawba, of North and South Carolina, the Oconee of Georgia, the Tennessee River, of Tennessee, and the Alabama River, of Alabama. This older section of the South, with its numerous cotton mills, lumber factories and iron plants, has come to be a great user of power.

With steam coal at three dollars and more per ton in many sections of the South, there is a general turning to the rivers to solve the problem of cheap power, and the industrial advance of this section during the past decade has been largely based on water power.

In this situation electrical transmission has proved to be of prime importance, for the southern railways follow the high lands rather than the river valleys, and manufacturing plants must have cheap transportation as well as power. While electricity thus forms a perfect link between the industries of the South and its great source of power, there remains a weakness in that source which must as far as possible be cured—that is, the lack of constancy.

Unlike the power streams of New York and New England, with their numerous lakes and ponds, or those of California, with their great artificial reservoirs, the rivers of the South have but little storage capacity in most instances, as thus far developed. This characteristic of the southern rivers is all the more important in its bearings on the situation because the great power demands of the South are made by day rather than by night, and are in the main continuous through all the months of the year.

A result of the above is that the hydroelectric systems of the South have to be supplemented largely by steam power in many instances, such steam power being installed either by the electric systems or their customers. More than this, where an electric system is not in a position to guarantee constant power, it must accept lower rates per unit for its output. If the amount of electric power that can be supplied is uncertain, the consumer is less inclined to accept it at any price, and the installation of a steam plant equal to his entire demand puts him in a very independent position.

Such an instance came up last year at one of the large cotton mills of the South that is within transmission distance of three large hydroelectric plants, two of which are under construction and the third in operation, but neither of which could deliver constant power. At this mill plant the cost of run-of-mine steam coal is $3.70 per short ton, and yet a steam-boiler plant of 5,700 horsepower was installed to operate electric generators rated at 5,500 kilowatts, to supply power for the mills. When these mills take energy from one of the above hydroelectric plants, it can hardly be doubted that the interest and maintenance charges on the steam plant will affect the rate paid for transmitted power.

Storage of two quite different capacities is desirable on the southern rivers; first, storage to hold the entire flow of a

stream during the night for use during the day, so as to double the mill load that may be operated during periods of low or moderate flow. The other class of desirable storage must have sufficient capacity to carry water from periods of large flow over several weeks or months of small flow, so as to increase materially the output of the plant during such dry periods.

It is safe to say that enough storage to hold the night flow at times of low discharge can be created at a large percentage of the large waterpower sites on southern rivers, if the developments are planned with this object in view.

How far the much greater storage capacities necessary to carry the surplus water of wet periods over several weeks or months of low river discharge can be created is a matter worthy of much investigation and study. Such reservoirs can no doubt be created at many points among the Appalachian Mountains, where most of the rivers under consideration have their source, but private interests can hardly be expected to construct such reservoirs at the headwaters of a stream unless they control most of the power sites along its course.

In some instances, however, it is practicable to create reservoirs at the power sites that will at least double the minimum flow of the stream during several weeks, and thus increase in the same ratio the amount of constant power. There is one such power site on a large southern river where high rocky banks permit a reservoir about ten miles long with a water surface of more than 100,000,000 square feet above the dam to be created. During three months of a recent dry year the discharge of the river at the power site just mentioned averaged about 1,500 cubic feet of water per second, amounting, if stored during the night, to 3,000 cubic feet for use on the wheels during twelve hours of each day. By a reduction of less than seven per cent in the head of the water at the dam, the above reservoir might have yielded 500 cubic feet per second from its stored water during the entire three months in question, or 1,000 cubic feet per second during twelve hours on each of seventy-five working days. This would have increased the available water from 3,000 to 4,000 cubic feet per second during twelve hours on each working day of the dry period.

The hydroelectric plants thus far constructed in the South show widely different storage capacities along their several streams, according to the areas of the reservoirs created by the dams. At one plant under construction for a capacity of 25,000 kilowatts the length of the reservoir behind the dam is about one-and-one-half miles and its water surface is some 10,000,000 square feet.

A plant operating with 24,000 kilowatts capacity has a storage area about three miles long and from 1,000 to 2,000 feet wide behind its dam. One of the best storage reservoirs in the South is behind a dam that maintains a head of twenty-five feet for a station containing generators of 6,600 kilowatts capacity. This reservoir extends twelve miles upstream, where the width is perhaps 1,000 feet on an average. More long reservoirs like this are to be desired.

## INCREASE OF FLAMING ARCS AT BOSTON.

Some weeks ago attention was called to the use of flaming arc lamps at Copley and Park squares in Boston, and a considerable extension of this method of street lighting has since taken place there.

These flaming arcs operate with 6.7 amperes direct current and require 500 watts each. They are rated at 1,600 candlepower. According to the tests on the candlepower of these lamps, last April and May, while they were in regular operation at Copley Square, their average intensity at twenty-five degrees below the horizontal was 2,500 to 3,000 candles each.

The first installation consisted of three lamps at Copley Square mounted at the tops of poles with the center of each globe fifty-two feet above the ground. The results with these three lamps were so satisfactory that a fourth was added in the square to make a permanent installation, and nine of the 500-watt 6.7-ampere enclosed arc lamps that had been in use to light the square were displaced.

For these nine enclosed arcs, which operated with direct current, the total energy required was 4,500 watts, the aggregate candlepower at normal rating was 3,600, and the annual cost to the city was $831 for 3,828 hours of lighting. With the four flaming arc lamps now in use the total power is 2,000 watts, or something over forty per cent of the former amount; the combined candlepower as rated is 6,400, an increase of nearly eighty per cent, and the annual rate to the city is $625, or twenty-four per cent less than before. As a matter of general observation, there can be no doubt that Copley Square is much better lighted than formerly.

Between the fronts of the buildings on its opposite sides Copley Square measures approximately 400 by 400 feet, and thus contains some 160,000 square feet. As now lighted with the four flame arcs, the consumption of power is thus about 0.0125 watt per square foot.

Two flame arc lamps were also placed in Park Square last spring, and now there are in place or in process of erection sixteen other flame arcs at prominent points about the city of Boston, making a total of twenty-two of this type.

For the additional sixteen flame arcs the locations are one each in Adams, Post Office, Columbus, Merrimac, Central, Maverick, Breed, Pierce and Edward Everett squares; one at the Common and Beacon Street, Center and South streets and South Street and the Parkway, respectively; also two at North End Park and two on the Common.

In Park Square the two flame arcs have the centers of their globes forty-three feet above the ground, and at the other locations this type of lamp is placed much higher than were the enclosed direct-current arcs that were displaced.

Besides the above permanent installation of flame arcs, more than a dozen of these lamps were used temporarily to light Huntington Avenue and the outside of the Mechanics Building during the recent Boston Electrical Show. Many American cities might advantageously follow Boston's example.

### Chicago Arranging for the Complete Electric Lighting of its Streets.

The city of Chicago has in service for public street lighting about 13,000 arc lamps. It has been estimated that in order to completely light up all of its streets, many of which are now still illuminated by gas and gasoline lamps, it will require a total of about 29,000 arcs. Alderman B. W. Snow, chairman of the finance committee of the City Council, has taken up the matter with the Sanitary District of Chicago, from which other municipal body the bulk of the current now used for street lighting is secured. In a letter to President McCormick, of the district trustees, he sought the latter to consider the proposition of financing the extension of the electric service to all of the streets, which would require an investment of $2,000,000 to $2,500,000. As an alternative proposal, it was hoped to have public approval of a bond issue to this extent, but the latter scheme seems to be somewhat doubtful of being carried out.

President McCormick has made a counter proposition to the city, offering to purchase the city's transmission lines and substations now in service for bringing the Sanitary District's current from its main substation. The District has other substations located in the city limits, the lines running to some of which duplicate those of the city. The finances of the Sanitary District are in first-class condition, whereas those of the city are far from this state of affairs. The money that the city would get from the sale of its substations and lines to the district it could use advantageously for the installation of additional arc circuits. Considerable economy is expected from such an arrangement. In fact, President McCormick estimates that if the various governing bodies included within the borders of the Sanitary District would make more complete use of its hydroelectric power generated at Lockport, the resulting saving to the community at large would be no less than $1,000,000 a year. In this connection it may be said that the Sanitary District has for some time been urging the city to equip its pumping stations for electric service, so that it may be able to shut down all of its steam-driven plants, except for emergency service. By both these services the district would be enabled to build up its load factor to nearly 100 per cent both night and day. At present the Lockport plant is running much below capacity and the district tries to sell its surplus power for commercial purposes.

### Wisconsin Electrical Association.

The first regular annual convention of the Wisconsin Electrical Association will be held on January 19 and 20, 1910, at the Hotel Pfister, Milwaukee, Wis. It will be remembered that this association is the consolidation and successor of the old Northwestern Electrical Association and the Wisconsin Electric and Interurban Railway Association, the merging of the two former bodies having taken place at the joint meeting held at Waupaca, Wis., June 28 and 29 last.

The arrangements for the coming meeting give promise that it will be one of exceptional interest as the best energies of all the electrical men in Wisconsin are represented in the new association. The programme is not sufficiently settled as yet, however, to permit of public announcement. The secretary and treasurer of the association is John S. Allen, of Lake Geneva, Wis.

### National Electric Light Association to Investigate Terminology.

The November *Bulletin* of the National Electric Light Association makes the following announcement regarding the work of the terminology committee, of which W. H. Gardiner is chairman. This memorandum is as follows: "With respect to the work of the committee on terminology, the understanding is that this committee was appointed to draw up definitions of various terms used in the central-station business, and regarding which there may be some present confusion; and, if necessary, even to devise new terms. It is intended that the scope of the work of the committee cover the physical and technical departments of the business as well as the commercial end. Therefore, types of apparatus will be defined, as well as such items as "load factors" and various rates and methods of charging.

"The members of the committee on terminology are at present engaged in preparing as comprehensive lists as they each individually can, of such items or terms as seem to require definitions. I therefore, wish, at this time, to ask, through the *Bulletin* of the National Electric Light Association, those who are interested in this work to co-operate by forwarding to me lists of such terms as, in their judgment, may require definition. By the middle of December a complete composite list will be made up from all such lists, and will then receive the attention of the committee for individual definitions of each of its items.

"It is obvious that this work is one of moment, also one of magnitude and some difficulty, requiring the thorough consideration of very many items. I trust, therefore, that the committee will receive prompt co-operation from the members of the Association."

### Ohio Society of Mechanical, Electrical and Steam Engineers.

The twentieth meeting of the society took place at Lima, Ohio, on November 19 and 20 last.

President F. W. Ballard took for the subject of his address "Power Costs for Factories." The speaker recommended the keeping of detailed cost accounts of operating machines in a factory, and also discussed the pros and cons of utilizing exhaust steam for heating buildings. He pointed out the economy of electric-driven pumps over those driven by steam, and mentioned further that the first requisite of low-service cost is a system of accounting and follow-up records. A discussion of electric motor drive concluded the address.

Other papers presented were as follows: "New Mechanical Engineering Laboratory at the Ohio State University," by Prof. E. A. Hitchcock (abstracted by Professor Magruder in the author's absence); "The Darling Oil Gas Producer," by A. B. Davis; "Turbine Pumps," by Wetmore H. Titus; "Coal-Handling and Ash-Handling Equipments," by David Gaehr.

The following officers for next year were elected: President, O. F. Rabbe; vice-president, Grant Miller; secretary, Prof. F. E. Sanborn, Ohio State University, Columbus, Ohio; managers, Ira Cole, C. T. Baker and E. E. Adams.

Cincinnati was selected as the place of the next morning.

### Public Service Commission Orders for Car Heating.

An order has been served upon all street-railroad companies in New York by the Public Service Commission, requiring that all closed electric and horse cars in service between October 15 and April 15 shall be equipped with suitable apparatus for heating. Whenever the temperature is less than forty degrees Fahrenheit a temperature not less than forty nor more than sixty-five degrees above zero must be maintained, unless the company is temporarily prevented from so doing by storms, accidents, or other emergencies beyond its control, and for which it is not responsible. This order is to take effect December 10.

### American Association of Electric Motor Manufacturers.

At the semi-annual meeting of the American Association of Electric Motor Manufacturers, held at St. Louis, Mo., on November 15, 16, 17 and 18 last, the provisional reports of the committees on standard motor speeds, standard pulleys and standard motor dimensions were presented, and the committees (which are working in conjunction with the National Machine Tool Builders' Association) were authorized to complete their investigations. Mention was made of the committee, which is working conjointly with a committee appointed by the National Electric Light Association, to draw up a very complete table of motor data and applications. The report of these committees will shortly be published by the association.

The next meeting of the association will be held some time in May, 1910, at Hot Springs, Va.

### Chicago as Headquarters for the Sons of Jove.

At the seventh annual meeting of the Order of Rejuvenated Sons of Jove, held in Cleveland, Ohio, October 14 and 15, an account of which appears in the ELECTRICAL REVIEW AND WESTERN ELECTRICIAN of October 30, Roy M. Van Vliet, manager Chicago office of the Cutler-Hammer Manufacturing Company, was elected Mercury.

This office for the past four years has been held by C. B. Roulet, of Dallas, Texas, and Chicago members of the association point to the change with pride, as the headquarters will now be in that city. The *Jovian Bulletin,* the official publication of the Sons of Jove, will now be published from the new headquarters in Chicago.

### Electricity in Canadian Iron Mines.

The Grenville iron mines, which are located about half way between the Canadian cities of Montreal and Ottawa, make an extensive use of electric power for driving the various plants, as well as for lighting, pumping and hoisting. Most of the current is generated by the central power house, erected in 1903, which contains a 750-kilowatt alternating-current generator direct-connected to a 1,000-horsepower Nordberg-Corliss engine. There is another smaller power house containing a 200-horsepower engine and a 150-kilowatt generator, as well as a supplementary generating station on the Bouquet River for supplying extra power when required.

### Removing Cancer by Electricity.

Dr. G. Hauer Everhart, of St. Luke's Hospital, Baltimore, Md., recently made what is stated to be the first operation in this country of Dr. E. Doyen's method of removing cancer by electricity.

The cancerous growth was located in the patient's mouth in this particular case. After the tissues were softened by the application of very hot sterilized air, the electrical currents were applied in such a manner as to kill entirely the growth in a way not possible with the surgeon's knife.

Dr. E. Doyen is an eminent French surgeon, and his process of applying electricity in the cure of cancer is designated "fulguration." It is claimed that the new method is an absolute success and that a recurrence of the disease is not possible when a thorough application of "fulguration" has been made.

### New England Section, Illuminating Engineering Society.

The November meeting of the New England Section of the Illuminating Engineering Society was held on the evening of November 16 at the Edison Building, 39 Boylston Street, Boston. The general subject of discussion was "The Technique of the Application of Gas and Electricity in the Best Lighting of Modern Homes." The possibilities for the use of gas for this service were discussed by T. J. Little, of Gloucester, N. J. The availability of electricity in this line was presented by H. W. Moses and E. C. Kimball, of the Edison Electric Illuminating Company of Boston. There was a spirited discussion by the followers of each system, and the meeting was one of the best that has been held for a long time.

### Transmitting Pictures Across the Atlantic.

Telegraphing pictures from London to New York is the problem at present engaging the attention of several scientists. In a lecture given before the Royal Society of Arts at London a few days ago Thorne Baker said that Professor Korn was likely to find a practical solution of sending photographs by the ordinary cable across the Atlantic, while he himself was endeavoring to perfect a wireless system for the same purpose, which had already given promising results in his laboratory.

A complete series of photographs was shown illustrating the progress that had been made since the first instruments of Professor Korn were installed in November, 1907, at the offices of *The Daily Mirror.* It is said that the Korn telautograph and the Thorne Baker telectograph will enable photographs of all kinds to be telegraphed for publication with a fair measure of success. The improvement in the processes of transmission within this relatively brief period is striking.

### To Test Corporation Law.

In a recent suit brought in the Supreme Court of California, the Merced River Electric Company is attacking the state law which prevents corporations from creating a bonded indebtedness greater than the initial subscription of stock. This suit involves the question of whether the Secretary of State can be compelled to file corporation papers not in accordance with the law.

While the subscribed stock of the company is only $2,500, it is capitalized for $1,500,000, and wants to bond itself for an amount equal to the entire capital.

### Reducing Smoke in the "Black Country" in England.

The "Black Country" in England has long been the popular designation of the great manufacturing district in South Staffordshire, in England, where even the very vegetation is blackened by the dirty pall of smoke which always hangs over the landscape.

A writer in a recent number of the *Windsor Magazine,* a popular British monthly, gives some particulars of a scheme which is being promulgated for doing away entirely with this smoke nuisance in the Black Country.

The idea of this scheme is to use the coal fuel, not in ordinary boiler furnaces, but in Mond producers, the resulting producer gases to be employed in driving gas engines coupled to electric generators at large central stations. The electricity will then be used for operating motor-driven installations in the various factories.

### Missouri Attacks Bell Mergers.

Dispatches from Jefferson City, Mo., state that Attorney-General Major has received complaints from various parts of the state that the Bell Telephone interests are purchasing control of many Independent companies in Missouri. He has announced such purchases are violations of the state's antitrust laws. He is preparing to proceed in the Supreme Court either by asking for the appointment of a commissioner to take testimony or by ouster direct or by injunction, to prevent the Bell Telephone Company from purchasing other companies.

### Chicago Electric Club.

The regular midday luncheon of the Chicago Electric Club, held on Wednesday, November 24, was followed by an interesting address by George P. Barton, senior member of the firm of Barton & Folk, who chose for his subject "The Trend of Invention."

In introducing the subject, Mr. Barton said that the Electric Club is representative of industries which in all their branches have been founded upon inventions that have been patented. The trend of inventions may be viewed in three aspects: First, with respect to the inventions themselves from the engineer's standpoint; second, with respect to the rules and regulations and practice by which the inventor secures his lawful monopoly; and third, the influence of inventions upon society.

Confining himself to the second aspect, the speaker referred to April 30, in the year 1789, when the present form of government was inaugurated and the constitution went into effect with a provision relating to patents. In showing the wonderful development in patents since that time, the following statistics were quoted: In the year 1800 only forty-one patents were issued by the United States; in the year 1850, excluding patents for designs, there were issued some 884 patents for inventions; during the year 1900 there were issued 24,660 patents; and during the fiscal year, ended June 30, 1909, there were granted 34,332 patents for inventions. Assuming that there are now existing over 400,000 unexpired patents, the speaker stated that these patents contain in the aggregate at least 2,000,000 claims; that he had not counted them; that there might be three or four million. He said that some looked upon these outstanding patent claims as a menace to our industries. He said, however, that the great majority of patents were worthless, not benefiting anyone unless the solicitors; that one employe of an advertising agency had written over 15,000 applications for patents, earning for himself $60.00 a week on ten per cent of the amount charged the inventors by the agency.

That the examiners of the Patent Office, in association with the solicitors of patents, have worked out a code of patent law well understood between themselves, incomprehensible to the laymen, incomprehensible to foreign nations, and hardly recognized by the courts, was demonstrated in the case between the Benjamin Electric Manufacturing Company and the Dale Company. In this case the Benjamin company, on the strength of its invention, asked for seven claims, and by the time the Patent Office was through with the company it was the holder of four separate patents, granted upon divisional applications split off from the original one, the four patents containing altogether ninety-eight claims.

The speaker stated that there were now forty-two separate examining divisions in the Patent Office and 400 or more examiners; that the examiners would usually require division of an application when search was required in more than one division; that solicitors of patents, largely compensated by a fixed fee for each application, were apt to view with complacency the multiplication of their fees by acts of the Patent Office in requiring division. This divisional attenuation or splitting up of a single invention into numerous patents and claims was marked and significant; that this trend of invention was not for the benefit of inventors, investors in patents, manufacturers or the public.

Mr. Barton referred also to the embarrassments experienced by patentees in enforcing their rights in the courts, and made reference to the recent decision in the Selden Automobile Patent Cases, the court having stated, as a horrible example, that the record comprised thirty-six large octavo volumes which clients had to pay for.

In reply to a question as to the position of the legal profession on the subject of establishing a technical trial court, Mr. Barton said that in the Patent Office the examiners were educated, technical men; that there had been no action taken toward establishing technical trial courts to hear patent causes, but that the American Bar Association had recommended the establishment of a Patent Court of Appeals; that patent lawyers generally favored this, since there are now ten Courts of Appeal, counting the Court of Appeals for the District of Columbia, each for a different portion of the country, having final appellate jurisdiction in patent matters; that the proposed plan was to appoint a chief justice and to designate as his associates four circuit judges, who, presumably, would be named on account of their eminence in patent law.

### The Big Independent Telephone Convention.

As previously announced, the next convention of the International Independent Telephone Association will be held at the Auditorium Hotel, Chicago, December 7 to 9, inclusive. Arrangements are practically complete for an unusually large and successful meeting. The large number of rumors concerning the affiliation of various Independent telephone companies that have recently been current have resulted in exceptional interest being taken in the coming meeting by all stanch followers of the Independent movement. As usual an extensive exhibit of telephones and telephone appliances will be made in connection with the meeting. As a reminder of the forthcoming convention there is being distributed a large folder showing a photographic reproduction of Chicago's water front with a conspicuous indication of the Auditorium Hotel, where the meetings are to be held.

### Alabama Light and Traction Association.

The annual convention of the Alabama Light and Traction Association was held at Birmingham, Ala., on November 15 and 16. Among the papers presented were the following:

"Some of the Worries and Duties of the Central-Station Manager in a Small Town," by C. C. Henderson; "Public Service Possibilities," by C. D. Armstrong; "School for the Manager," by T. K. Jackson; "A Visible Side of Accounting," by G. S. Emery. C. M. Cory gave a talk on the corporation tax law, and Prof. E. E. F. Creighton delivered an interesting lecture on lightning arresters that was illustrated by experiments.

At the conclusion of the meeting the following were elected officers for the coming year: G. Howard Wilson, president of the Mobile Light and Railway Company, president; R. L. Rand, vice-president; Lloyd Lyon, of Mobile, secretary-treasurer.

### Pittsburg Electric Booster Club.

The Pittsburg Electric Booster Club held its monthly "Short Circuit" at the Duquesne Hotel on the evening of November 29. The meeting was preceded by the usual dinner, after which A. P. Munning, general sales agent of the Cutler-Hammer Manufacturing Company, made an address on "Seventeen Years in the Development of the Controller Industry." H. F. Hetzel, of the Vesta Coal Company, enlivened the proceedings by his excellent rendition of a number of violin solos. The Midnight Quartette aided materially along similar lines, and on the whole the meeting was one of the most pleasant that has yet been held by the Pittsburg Electric Boosters.

# THE DETERMINATION OF CIRCLE COEFFICIENT OF THE INDUCTION MOTOR.

BY H. M. HOBART.

The quality of an induction motor is very dependent upon the value of $\sigma$, the circle coefficient,[1] and, other things being equal, the lower the value of the circle coefficient, the better is the induction motor. The general order of magnitude of the circle coefficient ranges between 0.03 and 0.10, and depends chiefly on the rated speed and periodicity and on the rated output.

A conception of the physical significance of $\sigma$ cannot well be discussed within the limits of this article, the main object of which is to set forth a practical empirical method of estimating $\sigma$.

Some years ago, Behrend proposed that the circle coefficient should be estimated from the formula

$$\sigma = C \times \frac{\Delta}{\tau}$$

in which C is a factor stated by Behrend to depend "upon the shape and size of the slots and upon a great many other conditions of which we are still profoundly ignorant."[2] Behrend stated that for partly open slots, C varies between 10 and 15. The quantities $\Delta$ and $\tau$ denote, respectively, the values of the radial depth of the air gap and of the polar pitch at the air gap, both expressed in centimetres. It is important that it should be clearly realized that $\sigma$ is a quantity which is not capable of exact predetermination. It is for this, among a number of reasons, that it is generally useless, in the practical designing of induction motors, to employ the highly mathematical theories which have been framed with the intention that they should be used by designers in predetermining $\sigma$. Sanely viewed, many of these theoretical investigations are valuable, but in so far as they tend to instill the impression that a high degree of accuracy is attainable in the predetermination of the circle coefficient of an induction motor, they are misleading and harmful.

The author's method of estimating $\sigma$ has been largely based on the analysis of a large collection of experimental data. Here again a difficulty is encountered. The experimental observations are themselves subject to a probable error of a large amount, and it is safe to say that many of the experimental results which are believed to be quite accurate by those who have made the tests, are often inaccurate to the extent of thirty per cent and more. The method of test is rarely reported; the radial depth of the air gap is difficult to measure with any accuracy; the measuring instruments are often out of order, and finally, large mistakes are generally made by the test-room staff in entering up their results and in making their calculations from these data.

Nevertheless, in the large numbers of tests of which the author has brought together the alleged correct results have been of great value as affording the necessary basis for the empirical method which will now be described.

During the last five years the author has devised several methods[3] for predetermining $\sigma$. While each of these has led to good results for certain ranges of conditions, no one of these has thoroughly sufficed for the wide range of values of

TABLE I.—OBSERVED AND ESTIMATED VALUES, FOR $\sigma$, THE CIRCLE COEFFICIENT OF THE INDUCTION MOTOR, FOR 71 POLYPHASE INDUCTION MOTORS.

| Size of Motor. | Reference Number. | Diameter at Air Gap — D — cm. | Gross Length of Core — $A_g$ — cm. | Net Length of Core — $A_n$ — cm. | Number of Poles. | Pole Pitch $\tau$ — cm. | Radial Depth of Air Gap — $\Delta$ — mm. | Number of Stator Slots. | Number of Rotor Slots. | Average Number of Slots per Pole — H. | Squirrel Cage or Slip Ring. | Observed Value of Circle Coefficient $\sigma$. | Estimated Value of Circle Coefficient $\sigma$. | Discrepancy—Per Cent. | Average Discrepancy. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SMALL. | 1 | 29.0 | 10.0 | 9.0 | 4 | 22.8 | 0.65 | 72 | 96 | 21 | Slip Ring | 0.060 | 0.053 | −12 | |
| | 2 | 29.0 | 10.0 | 9.0 | 6 | 15.2 | 0.65 | 72 | 96 | 14 | Slip Ring | 0.090 | 0.084 | −6 | |
| | 3 | 29.0 | 14.5 | 13.0 | 4 | 22.8 | 0.65 | 72 | 96 | 21 | Slip Ring | 0.045 | 0.044 | −2 | |
| | 4 | 29.0 | 14.5 | 13.0 | 6 | 15.2 | 0.65 | 72 | 96 | 14 | Slip Ring | 0.075 | 0.070 | −7 | |
| | 5 | 30.5 | 15.2 | 13.7 | 4 | 24.0 | 0.80 | 48 | 67 | 14 | Squirrel Cage | 0.056 | 0.068 | −14 | |
| | 6 | 31.7 | 15.0 | 12.6 | 2 | 48.5 | 1.50 | 30 | 49 | 20 | Squirrel Cage | 0.053 | 0.043 | −19 | |
| | 7 | 32.0 | 20.0 | 18.0 | 6 | 16.8 | 0.75 | 54 | 72 | 11 | Slip Ring | 0.055 | 0.068 | +24 | |
| | 8 | 35.6 | 11.4 | 10.3 | 8 | 14.0 | 0.82 | 72 | 96 | 11 | Slip Ring | 0.140 | 0.108 | −23 | |
| | 9 | 35.6 | 15.9 | 14.3 | 4 | 28.0 | 0.66 | 60 | 55 | 14 | Squirrel Cage | 0.052 | 0.040 | −23 | |
| | 10 | 35.6 | 15.9 | 14.3 | 6 | 18.7 | 0.66 | 72 | 55 | 11 | Squirrel Cage | 0.050 | 0.055 | +10 | |
| | 11 | 35.6 | 15.9 | 14.3 | 6 | 18.7 | 0.66 | 72 | 90 | 14 | Slip Ring | 0.060 | 0.062 | +3 | 11% |
| | 12 | 35.6 | 15.9 | 14.3 | 8 | 14.0 | 0.66 | 72 | 96 | 11 | Slip Ring | 0.090 | 0.084 | −6 | |
| | 13 | 35.6 | 15.9 | 14.3 | 8 | 14.0 | 0.66 | 64 | 55 | 8 | Squirrel Cage | 0.083 | 0.085 | +1 | |
| | 14 | 35.6 | 15.9 | 14.3 | 10 | 11.2 | 0.66 | 60 | 90 | 8 | Slip Ring | 0.130 | 0.115 | −12 | |
| | 15 | 38.0 | 20.0 | 18.0 | 4 | 30.0 | 1.90 | 72 | 105 | 22 | Squirrel Cage | 0.034 | 0.047 | +4 | |
| | 16 | 38.0 | 20.0 | 18.0 | 6 | 20.0 | 1.00 | 72 | 106 | 15 | Slip Ring | 0.066 | 0.062 | −6 | |
| | 17 | 38.0 | 20.0 | 18.0 | 8 | 15.0 | 1.10 | 72 | 105 | 11 | Slip Ring | 0.081 | 0.085 | +5 | |
| | 18 | 38.0 | 20.0 | 18.0 | 10 | 12.0 | 1.10 | 72 | 105 | 10 | Slip Ring | 0.099 | 0.090 | −9 | |
| | 19 | 38.0 | 24.0 | 21.6 | 6 | 20.0 | 0.80 | 54 | 72 | 11 | Slip Ring | 0.054 | 0.065 | +20 | |
| | 20 | 38.0 | 24.0 | 21.6 | 6 | 20.0 | 0.80 | 108 | 144 | 20 | Slip Ring | 0.039 | 0.043 | +10 | |
| MEDIUM. | 21 | 44.5 | 12.7 | 11.5 | 6 | 23.2 | 0.76 | 72 | 61 | 11 | Squirrel Cage | 0.048 | 0.061 | +13 | |
| | 22 | 44.5 | 12.7 | 11.5 | 6 | 23.3 | 0.76 | 72 | 90 | 14 | Slip Ring | 0.045 | 0.062 | +38 | |
| | 23 | 44.5 | 12.7 | 11.5 | 8 | 17.5 | 0.76 | 72 | 61 | 8 | Squirrel Cage | 0.062 | 0.072 | +2 | |
| | 24 | 44.5 | 12.7 | 11.5 | 8 | 17.5 | 0.76 | 72 | 96 | 11 | Slip Ring | 0.090 | 0.086 | −4 | |
| | 25 | 44.5 | 12.7 | 11.5 | 10 | 14.0 | 0.76 | 60 | 61 | 6 | Squirrel Cage | 0.120 | 0.112 | −7 | |
| | 26 | 44.5 | 12.7 | 11.5 | 10 | 14.0 | 0.76 | 60 | 90 | 8 | Slip Ring | 0.170 | 0.135 | −20 | |
| | 27 | 44.5 | 12.7 | 11.5 | 12 | 11.7 | 0.76 | 72 | 96 | 7 | Slip Ring | 0.176 | 0.137 | −22 | |
| | 28 | 44.5 | 16.5 | 14.8 | 6 | 23.0 | 1.00 | 90 | 140 | 2 | Slip Ring | 0.042 | 0.053 | +26 | |
| | 29 | 46.0 | 30.5 | 28.5 | 4 | 36.0 | 2.50 | 72 | 119 | 24 | Squirrel Cage | 0.048 | 0.049 | +2 | |
| | 30 | 49.0 | 19.0 | 17.0 | 4 | 38.5 | 0.70 | 72 | 120 | 24 | Slip Ring | 0.032 | 0.030 | −12 | |
| | 31 | 49.0 | 19. | 17.0 | 6 | 25.7 | 0.8 | 72 | 120 | 16 | Slip Ring | 0. 50 | .048 | −4 | |
| | 32 | 49.0 | 19.0 | 17.0 | 8 | 19.3 | 0.70 | 72 | 120 | 12 | Slip Ring | 0.064 | 0.065 | +2 | |
| | 33 | 49.0 | 19.0 | 17.0 | 8 | 19.3 | .80 | 72 | 120 | 12 | Slip Ring | 0.063 | 0.065 | +3 | |
| | 34 | 49.0 | 28.0 | 25.0 | 6 | 25.7 | 0.80 | 72 | 120 | 16 | Slip Ring | 0.042 | 0.044 | +5 | |
| | 35 | 49.0 | 28.0 | 25.0 | 8 | 19.3 | 0.80 | 72 | 120 | 12 | Slip Ring | 0.056 | 0.056 | 0 | |
| | 36 | 50.0 | 21.5 | 19.5 | 4 | 39.0 | 1.50 | 60 | 84 | 18 | Slip Ring | 0.051 | 0.050 | −2 | |
| | 37 | 50.0 | 21.5 | 19.5 | 6 | 26.0 | 1.60 | 108 | 126 | 20 | Slip Ring | 0.058 | 0.060 | +3 | |
| | 38 | 50.0 | 21.5 | 19.5 | 8 | 19.7 | 1.30 | 120 | 141 | 16 | Slip Ring | 0.065 | 0.066 | +3 | |
| | 39 | 50.0 | 21.5 | 19.5 | 10 | 15.8 | 1.40 | 120 | 141 | 13 | Slip Ring | 0.078 | 0.081 | +4 | |
| | 40 | 50.0 | 28.0 | 25.0 | 8 | 19.7 | 1.00 | 72 | 96 | 11 | Slip Ring | 0.060 | 0.065 | +8 | 9.3% |
| | 41 | 53.3 | 14.6 | 13.0 | 8 | 21.0 | 1.14 | 72 | 120 | 12 | Slip Ring | 0.091 | 0.085 | −6 | |
| | 42 | 53.3 | 19.7 | 17.7 | 4 | 42.0 | 1.14 | 72 | 67 | 17 | Squirrel Cage | 0.030 | 0.033 | +17 | |
| | 43 | 53.3 | 25.0 | 22.5 | 8 | 21.0 | 1.25 | 72 | 120 | 12 | Slip Ring | 0.089 | 0.073 | −18 | |
| | 44 | 58.0 | 24.0 | 21.6 | 8 | 22.8 | 0.90 | 96 | 144 | 15 | Squirrel Cage | 0.037 | 0.043 | +16 | |
| | 45 | 58.0 | 24.0 | 21.6 | 8 | 22.8 | 0.90 | 96 | 144 | 15 | Slip Ring | 0.054 | 0.053 | −2 | |
| | 46 | 58.0 | 24.0 | 21.6 | 8 | 22.8 | 1.10 | 96 | 144 | 15 | Slip Ring | 0.062 | 0.057 | −8 | |
| | 47 | 58.0 | 30.0 | 27.0 | 4 | 14.0 | 0.70 | 144 | 180 | 35 | Slip Ring | 0.022 | 0.023 | +4 | |
| | 48 | 58.0 | 30.0 | 27.0 | 8 | 14.0 | 0.70 | 120 | 160 | 18 | Slip Ring | 0.042 | 0.043 | +2 | |
| | 49 | 76.5 | 22.3 | 20.0 | 6 | 40.0 | 1.58 | 108 | 126 | 20 | Slip Ring | 0.036 | 0.046 | +27 | |
| | 50 | 86.0 | 25.0 | 22.5 | 10 | 27.0 | 1.50 | 150 | 252 | 20 | Slip Ring | 0.065 | 0.058 | −11 | |
| | 51 | 88.0 | 36.0 | 23.3 | 12 | 23.0 | 1.50 | 180 | 216 | 17 | Slip Ring | 0.052 | 0.057 | +9 | |
| | 52 | 90.0 | 17.0 | 15.3 | 12 | 23.6 | 1.00 | 144 | 180 | 14 | Slip Ring | 0.067 | 0.063 | −6 | |
| | 53 | 90.0 | 23.0 | 20.6 | 6 | 47.2 | 1.00 | 144 | 180 | 27 | Slip Ring | 0.033 | 0.032 | −3 | |
| | 54 | 90.0 | 23.0 | 20.6 | 12 | 23.6 | 1.00 | 144 | 180 | 14 | Slip Ring | 0.067 | 0.058 | −13 | |
| | 55 | 90.0 | 32.0 | 29.7 | 8 | 35.4 | 1.00 | 144 | 180 | 20 | Slip Ring | 0.043 | 0.037 | −23 | |
| | 56 | 90.0 | 32.0 | 29.7 | 12 | 23.6 | 1.00 | 144 | 180 | 14 | Slip Ring | 0.060 | 0.055 | −8 | |
| | 57 | 90.0 | 32.0 | 29.7 | 12 | 23.6 | 1.14 | 144 | 180 | 14 | Slip Ring | 0.065 | 0.058 | −11 | |
| | 58 | 94.0 | 40.0 | 36.0 | 12 | 24.6 | 1.00 | 108 | 144 | 11 | Slip Ring | 0.054 | 0.054 | 0 | |
| | 59 | 94.0 | 40.0 | 36.0 | 12 | 24.6 | 1.00 | 120 | 160 | 12 | Slip Ring | 0.054 | 0.053 | −2 | |
| LARGE. | 60 | 105.0 | 16.5 | 15.0 | 20 | 16.4 | 1.00 | 120 | 180 | 8 | Slip Ring | 0.115 | 0.110 | −4 | |
| | 61 | 105.0 | 42.0 | 38.0 | 16 | 20.6 | 1.45 | 192 | 288 | 15 | Slip Ring | 0.062 | 0.062 | 0 | |
| | 62 | 105.0 | 60.0 | 45.0 | 6 | 55.0 | 1.50 | 72 | 126 | 17 | Slip Ring | 0.033 | 0.034 | +3 | |
| | 63 | 130.0 | 30.0 | 25.5 | 16 | 25.5 | 1.60 | 128 | 240 | 12 | Slip Ring | 0.100 | 0.079 | −21 | |
| | 64 | 130.0 | 40.0 | 36.0 | 14 | 29.2 | 1.25 | 168 | 294 | 17 | Slip Ring | 0.050 | 0.045 | −10 | |
| | 65 | 150.0 | 22.0 | 20.0 | 16 | 29.6 | 1.50 | 144 | 182 | 11 | Slip Ring | 0.075 | 0.075 | 0 | |
| | 66 | 150.0 | 22.0 | 20.0 | 16 | 29.6 | 1.50 | 192 | 216 | 13 | Slip Ring | 0.065 | 0.067 | +3 | 6.8% |
| | 67 | 150.0 | 28.0 | 25.0 | 14 | 33.8 | 1.00 | 168 | 210 | 14 | Slip Ring | 0.046 | 0.048 | +4 | |
| | 68 | 150.0 | 28.0 | 25.0 | 14 | 33.8 | 1.40 | 168 | 210 | 14 | Slip Ring | 0.055 | 0.057 | +4 | |
| | 69 | 170.0 | 22.5 | 20.0 | 28 | 19.2 | 1.60 | 420 | 378 | 14 | Slip Ring | 0.073 | 0.079 | +8 | |
| | 70 | 300.0 | 75.0 | 67.5 | 30 | 31.4 | 1.75 | 450 | 720 | 20 | Slip Ring | 0.036 | 0.042 | +16 | |
| | 71 | 314.0 | 41.0 | 37.0 | 72 | 13.7 | 2.30 | 864 | 648 | 11 | Slip Ring | 0.130 | 0.120 | −8 | |

[1] I have substituted the designation "circle coefficient" for the heretofore customary designation "dispersion coefficient" in the belief that, at the commercial designing stage, it is preferable to relieve the mind from all concern as to the physical significance of $\sigma$, and to concentrate attention on the circle diagram relations which are based on this useful factor. This must not be taken as implying any wish to deprecate the importance of a clear understanding of the physical significance of $\sigma$.

[2] See p. 36 of Behrend's "Induction Motor."

[3] See "Die Wahl des Rotordurchmessers bei Induktionsmotoren," Elektrotechnische Zeitschrift, November 12, 1903, p. 933; "Die Vorausberechnung von und für Drechstrommotoren," Elektrotechnische Zeitschrift, April 28, 1904, p. 340.

$\tau$, $\lambda g$, $\Delta$ and H which are encountered in practice. The author has finally concluded that the object in view is best attained by employing a large collection of curves in the construction of each of which the method shown by practice to be most appropriate has been employed. The chart of curves, consisting of Figs. 1 and 2, incorporates the result of an attempt to put this view into practical form. Values obtained from this chart are appropriate for slip-ring induction motors. For squirrel-cage motors, the circle coefficient should be obtained by multiplying the chart values by 0.8. For convenience, the chart of curves for estimating $\sigma$ is divided into two sections, Figs. 1 and 2. These are arranged in order of increasing values of H, the average number of slots per pole. The smallest number of slots per pole for which curves are shown is six, as indicated at the head of the first column of curves in Fig. 1. The greatest number of slots per pole for which curves are shown is twenty-seven, as indicated in the last column of Fig. 2. It is only in rare instances that a number of slots per pole less than six is employed, as in such cases the slots are usually of undesirably large dimensions. For instance, with the largest polar pitch employed in Figs. 1 to 3, viz., forty centimetres, the slot pitch for $H = 6$ is 6.7 centimetres, which corresponds to a slot width of 3.35 centimetres if the slot and tooth are of equal width. On the other hand, large numbers of slots per pole lead to undesirably small slot dimensions.

Thus with a polar pitch of fifteen cen-

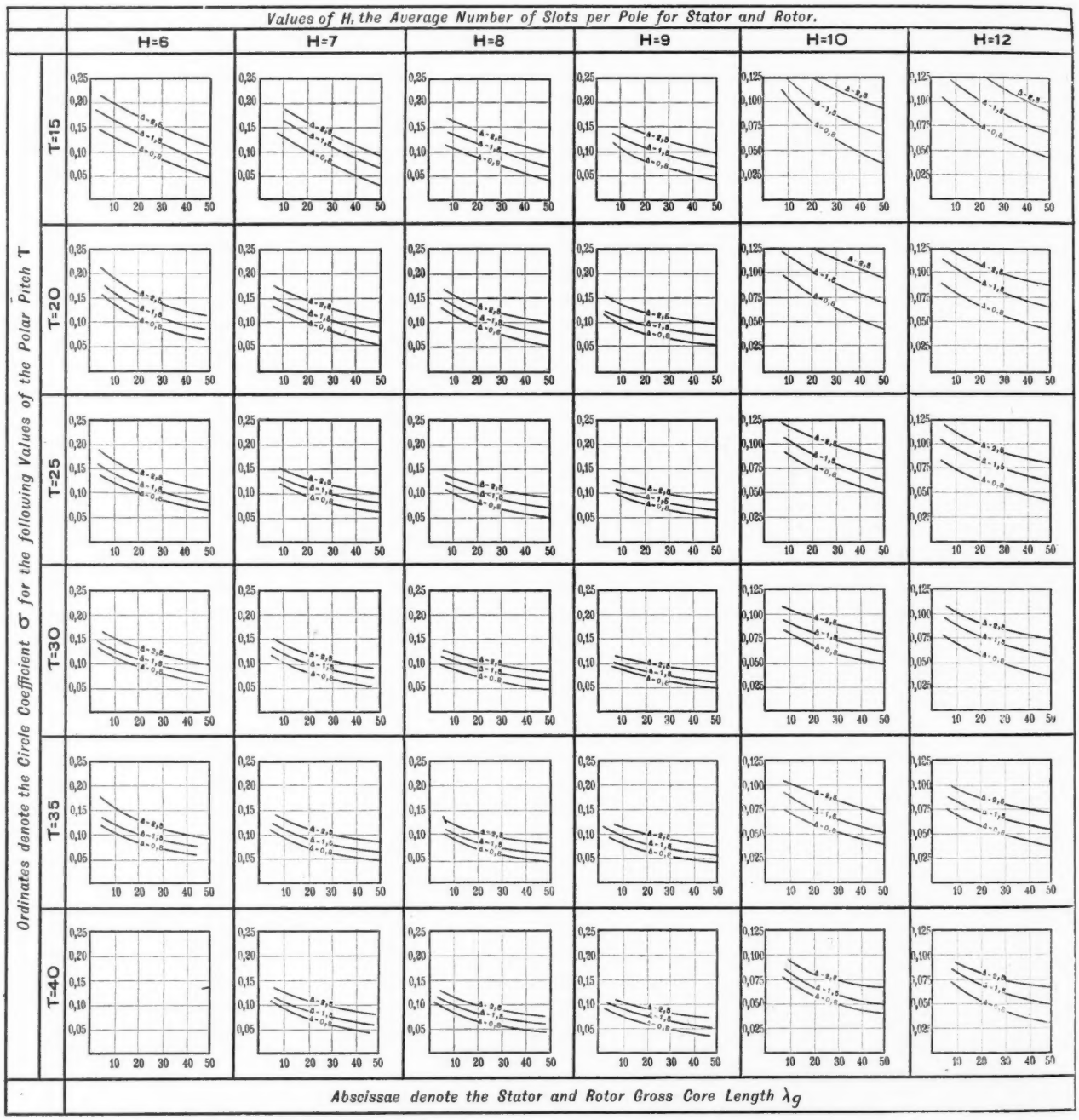



FIG. 1.—CURVES FOR THE ESTIMATION OF $\sigma$ THE CIRCLE COEFFICIENT OF THE INDUCTION MOTOR.

These Curves Apply to Induction Motors with Open or Semi-Closed Slots and with Wound (Slip-Ring) Rotors. For Squirrel-Cage Motors Multiply the Values Obtained from the Curves by 0.8. $\Delta$ Denotes the Radial Depth of Air Gap in Millimetres.

timetres (the smallest shown in Figs. 1 and 2), the slot pitch for H = 26 is only 0.6 centimetre, which is considerably too small to be practicable. It is for these reasons that curves for certain impracticable values of H and $\tau$ are not drawn a value considerably greater than is usually employed in present practice, nevertheless we have extended the curves to include these limiting values in order to make them quite comprehensive, and to indicate better the influence of the various factors. The lowest value of the slot pitch for the slotted curves is obtained for H = 18 and $\tau$ = 15 when the slot pitch is 1.2 centimetres. The largest values occur when H = 7 and $\tau$ = 40, which correspond to a slot pitch of 5.7 centimetres.

In Table I are given certain technical data of seventy-one induction motors, together with the observed experimental values of the circle coefficient and the values estimated by means of the curves in Figs. 1 and 2. The estimation of $\sigma$ for any of these motors from the curves is quite straightforward. For instance, motor No. 17, in Table I, has the following data: $\Delta$, the air-gap depth, is equal to 1.1 millimetres; $\tau$, the polar pitch, is equal to fifteen centimetres; $\lambda g$, the gross core length, is equal to twenty centime-

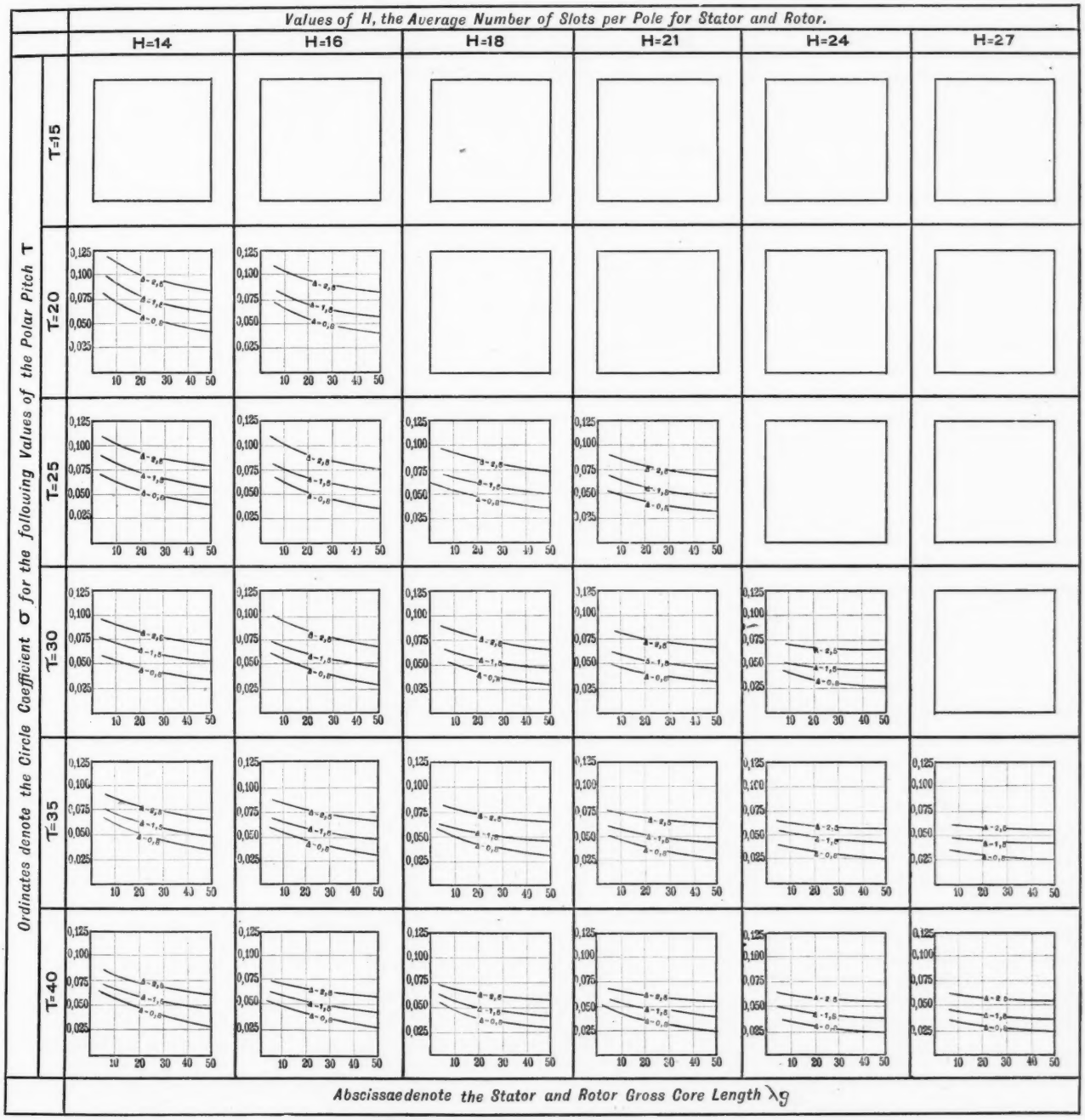



FIG. 2.—CURVES FOR THE ESTIMATION OF $\sigma$ THE CIRCLE COEFFICIENT OF THE INDUCTION MOTOR.

These Curves Apply to Induction Motors with Open or Semi-Closed Slots and with Wound (Slip-Ring) Rotors. For Squirrel-Cage Motors Multiply the Values Obtained from the Curves by 0.8. $\Delta$ Denotes the Radial Depth of Air Gap in Millimetres.

in Figs. 1 and 2. In Fig. 1 no curves are drawn for such values of H and $\tau$ as correspond to a slot pitch greater than six centimetres. In Fig. 2 no curves are drawn which correspond to a slot pitch of less than 1.2 centimetres.

While a slot pitch of six centimetres is

tres; H, the average number of stator and rotor slots, is equal to 11.1.

The curves for $\tau = 15$ and $H = 10$ are given in Fig. 2, column 1, and the top line, and for $\tau = 15$ and $H = 12$ in Fig. 1, column 2, top line. In the present case $H = 11.1$, which lies practically midway between $H = 10$ and $H = 12$. Hence we must interpolate between the values of $\sigma$ corresponding to $H = 10$ and $H = 12$. For $H = 10$, $\lambda g = 20$, $\Delta = 1.1$, the value of $\sigma$ is 0.083. Hence, for $H = 11.1$, $\sigma$ is approximately

$$\frac{0.087 + 0.083}{2} = 0.085$$

The observed value of $\sigma$ for this motor is 0.081. The discrepancy is 0.004, or five per cent, which is good agreement. It will be seen from the table that although in several cases there is a discrepancy of as much as twenty or thirty per cent, nevertheless the general agreement is very good.

The motors in Table I are arranged in the order of increasing values of D, the air-gap diameter. Motors having air-gap diameters up to forty centimetres are designated small motors; those with air-gap diameters from forty to 100 centimetres are designated medium-sized motors, and those with diameters greater than 100 centimeters are designated large motors. The average discrepancy between the observed and calculated values of the circle coefficient is entered in the last column of the table for each of these groups of motors. These discrepancies are obtained from the values calculated in the next to the last column for each of the motors. The + sign prefixed to the value of the discrepancy, signifies that the calculated value is greater than the observed value, and the — sign signifies that the calculated value is less than the observed value. In averaging these discrepancies in order to obtain the values in the last column, no account has been taken of the signs, but the values have been averaged arithmetically.

The discrepancies for the small, medium and large motors are, respectively, 11, 9.3 and 6.8 per cent. The discrepancy thus appears to decrease with the increasing size of motor. This is probably a chance occurrence, to which no significance should be attached. Nevertheless, it may be due to the fact that measurements on large motors may be made to a greater degree of accuracy, and the air-gap depths may be adjusted to a greater degree of precision than in small motors. These circumstances render the experimental values of the circle coefficient liable to greater error in small motors than in large motors.

In the calculation of the average discrepancy account may also be taken of the signs, indicating whether the discrepancy is positive or negative. The discrepancies calculated in this way are very small, as the positive and negative discrepancies neutralize to a large extent. The results calculated in these two ways are set forth in Table II.

TABLE II.—INDICATING DEGREE OF ACCURACY OF AUTHOR'S METHOD OF DETERMINING $\sigma$.

| No. of Motor. | Size of Motor. | Average discrepancy between the estimated and observed values of $\sigma$. Neglecting signs. | Taking account of signs. |
|---|---|---|---|
| 20 | Small ..... | 11% | — 3% |
| 39 | Medium .. | 9.3% | 0 |
| 12 | Large .... | 6.8% | — 0.4% |
| 71 | Average .. | 9.3% | — 0.95% |

It is difficult to draw any conclusions as to the relation between the proportions of the motor and the nature and value of the discrepancy between the observed and calculated values of the circle coefficient. Were such generalization possible, it would be practicable to correct the curves in the chart to give more accurate results. Such corrections can only be made in the light of further experimental values, and, pending the accumulation of more such data, the curves in Figs. 1 and 2 appear to give as accurate results as can be obtained by calculation.

## A European Electric Train-Lighting System.

Experience teaches that in an electric train-lighting system each car should constitute a complete and independent unit; that the use of the car should in no way be restricted on account of the lighting system, and that no regulation or adjustment by hand should be necessary whether the car runs at a high or low speed. This requirement of absolute independence makes severe demands on the automatic regulating apparatus. A device recently put on the market by Brown, Boveri & Company is intended to meet these conditions and at the same time prevent all overloads on the accumulators and thus increase and improve the economy of operation.

The individual car-lighting system of this firm comprises a direct-current shunt dynamo driven from a car axle by means of a belt or chain, an accumulator battery working in parallel with the dynamo, and a regulating apparatus, the duty of which is to conduct the energy produced by the dynamo to the battery and the lighting circuit in such a way that, under all conditions, the proper tension is supplied to the lamps and that the battery performs its normal functions of charging and discharging without overload. The dynamo is suspended pendulum-fashion from the car frame or truck, and the tension necessary for the belt or chain is supplied by its own weight or by springs. The position of the brushes is changed automatically when the car changes its direction of movement. The accumulators supply the current while the car is at rest, and they are usually so dimensioned that illumination may be maintained for seven to ten hours.

The chief object of the regulator is the control of the dynamo voltage, which of course varies with the speed of the car. When a train starts, the dynamo excites itself and its voltage rises with increasing speed until it has reached a value sufficient for charging the battery or lighting the lamps, when the machine is connected to the circuit by an automatic switch. The voltage would still continue to rise with increasing train speed, but this is prevented by inserting a resistance in the shunt circuit. This is effected automatically by means of the regulator, which revolves a contact segment under a number of contacts connected to resistance coils and places them in or out of circuit. The regulator consists of a magnetic field in which a coil is arranged so that it can rotate. The magnetic field is produced by two windings, one in shunt with the dynamo and the other joined to the battery, both working in the same direction. A third winding is connected with the lighting circuit and works in a direction opposite to that of the first two. The united effect produced by the windings produces a torque on the coil, which is resisted by a spring of such dimensions that it exerts a constant pull. This constant mechanical pull is maintained in equilibrium by the electrical torque on the coil, and this condition is utilized for regulating the resistance in the dynamo circuit. The system has been successfully introduced on the Swiss Federal Railways, and is being tested on lines between Berlin and Hamburg.—*Abstracted from Elektrotechnischer Anzeiger (Berlin), October 21.*

The 289th meeting of the New York Electrical Society was held at the Engineering Societies Building, New York city, on the evening of November 30. A. J. Marshall delivered an illustrated lecture on "The Significance of Public Decorative Lighting."

## DIPLOMACY IN BUSINESS.

BY WILLIAM WESTERFIELD.

We will assume that the object of every man in business is success. In order to be successful in business it is essential that every honorable means contributive to success be employed. There are many things that make for success that in a large measure are neglected by those whose first duty and aim should be to keep them in mind. It is a manifest folly to employ suave and diplomatic solicitors for the purpose of securing new business, while it may be there is a man at the manager's or cashier's window who, by failing to keep up the impressions made by the solicitor, constantly drive old business away.

There are certain common-sense rules of conduct that a man can apply to any business. It is very essential that those who deal with the public, have patience and forbearance, above all things. It may be urged that tact is most essential, but while we grant this, he must understand that tact is dependent upon the possession of patience and forbearance. Not only is tact required, but a good deal of diplomacy must sometimes be employed. True diplomacy is simply the sensible application of the old adage, that "a soft answer turneth away wrath." In order to stand before the storms of senseless wrath, as many business men do without resentment, one must have self-control, and every sense must be alert and active, in order that every advantage may be taken of the situation. A keen insight into human nature and human motives must be developed if success in dealing with the public is to be attained.

The man whose duty it is to deal with the public, and represent, say, a large, or even medium-sized central station, should be a man who can endure with unruffled countenance, things that other men would feel perfectly free to resent. A complaining patron comes in and, without ceremony, begins to abuse the company and everyone connected with it, because of some imperfection in the service, or the conduct of some employe, and no matter how much the same may be regretted by all interested, it is easy for the customer to assume that everything that is done is intentional, and he or she may not hesitate to assume that any shortcoming must be intentional. Often long and severe lectures are delivered by otherwise good customers with this assumption, though in sober moments they would acknowledge that they had nothing to support the assumption but a disordered imagination.

Now, to be abused, especially when one is innocent, is trying in the extreme to an untrained man. But if he will think a little, he will be able to get into a state of mind that will enable him to bear such demonstrations without seriously affecting him. We may assure ourselves that the people who do these things, soon after become heartily sorry, if not actually ashamed. They will realize in ninety-nine cases out of a hundred that they have not justified a good opinion of themselves. They will be self-condemned. Now if we allow ourselves to exhibit similar weakness in the presence of the people, it must be clear that we have lost standing in the eyes of those who condemn themselves for doing just what we have allowed ourselves to be vexed into doing. On the other hand, if we maintain our self-control, we will find that we have gained the respect of these people to such an extent that they will become ashamed to exhibit themselves to us after the manner of persons who lose sense and breeding over small vexations. If resentment is manifested, it also engenders permanent enmity, and may mean loss of business. There is no need to fear that the public will censure for lack of spirit. The Bible speaks well for the man who can rule his own tongue, and the people, as a matter of fact, admire a man who can do this. It is the part of wisdom.

I understand the desire common to most men to be victor over all things. There is but little honor to be hoped for as victor in a jawing match, but loss of self-respect is sure to be one of the results. If we want to win in a game of this kind, better we should do so through kindly indifference, or the timely pouring of "oil on the troubled waters." That is the really manly and wise method, and the more we employ it the more confidence we will have in it, and the more naturally we will be able to use it.

### Metropolitan Property Must Be Sold.

The Supreme Court of the United States has recently refused to review the decree of the lower courts ordering the foreclosure of the $12,500,000 mortgage of the Guarantee Trust Company on a portion of the property of the Metropolitan Street Railways Company of New York city. The writs of certiorari to the Circuit Court of Appeals in the same suit were denied. Judge E. Henry Lacombe, who ordered the sale, set a new date for the sale of the property as January 22.

### The Value of Mathematics.

In his inaugural address as chairman of the Birmingham (Eng.) Section of the Institution of Electrical Engineers, R. K. Morcom made the following remarks on the value of mathematics as a training:

"The value of mathematics, in particular, as a training, should never be overlooked. Given zeal, I believe that mathematics, and plenty of it, will take a man further than any other training. It will give him that most valuable commodity, a well-ordered mind. A common experience is that if a student experienced difficulty in, say, advanced arithmetic, he would go back to it as child's play after a bout with algebra, and when algebra begins to get vague a dose of differential will send him back to scoff at the former difficulty, and so on into higher fields. A sound mathematician can always more readily specialize on a physical subject than another man—he is trained to reason.

"Too many engineering textbooks are now written which make a boast of their non-mathematical nature. It certainly makes the book fatter and more expensive, but mathematics are labor-saving appliances, and should be used. Those who cannot use them should take the results they produce for granted, like a laborer with a complicated automatic.

"The number of successful barristers whose training has been mathematical is large, and any of us who have been in contact with a barrister on a technical subject must have been surprised at the great command of that subject which he can acquire at short notice. Take a mathematician, give him a workshop training, and let him read the technical papers instead of the sporting columns of the daily press, and he will make an engineer. If he also has the gift of common sense and zeal for his profession he will make a good engineer. An engineer whose knowledge of mathematics and pure science is rudimentary is to his truly educated confrère much what a pianola-player is to a pianist."

### December Meeting, American Institute of Electrical Engineers.

The December meeting of the American Institute of Electrical Engineers will be held on the evening of the 16th of this month in the Engineering Societies Building, New York city. A paper entitled "Comments on Development and Operation of Hydroelectric Plants," will be read by Henry L. Doherty.

# THE ROUGE-FAGET PERMUTATOR.

BY F. C. ZANZIG.

The history of the permutator dates back to 1888, but only recently has it been on the market as a commercial success. A description of the Rougé-Faget Permutator is herewith contained, besides some operating characteristics of a nine-kilowatt machine, tested in the dynamo laboratory of Armour Institute of Technology. However, before describing the permutator in detail, it may be well first to define and classify it under some general head.

A permutator, as the name implies, is from an electrical point of view a machine which permutates (changes) alternating current to direct current. It is a rectifier and not a converter, as will be brought out later, in that the change from alternating to direct current is accomplished by rectification and not conversion. This distinction is based upon the usual definitions of rectifiers and converters. In the former the magnetic circuit, if there be one, is not a function of the direct current; in the latter, the electric circuit is definitely related to the magnetic circuit.

It is well known that in a rotary converter a portion of the direct current is rectified alternating current and the remainder is generated due to generator action, the ratio depending upon the number of phases. In a permutator the direct current is produced by rectification only. Based upon this difference we may use the term, "rectifying apparatus or machine," as a class to which this machine belongs, or as will be evident from the following description, the permutator is a static transformer with a non-inductive rectifier. That is to say, while in the rotary converter synchronous rotation is used to some extent to induce direct currents, in the permutator synchronous rotation is used only to collect direct currents. Stated in still other words, the current collected from the commutator as direct current is not generated, either wholly or in part, as in a converter.

The machine consists of three essential parts, namely:

(a) A transformer having a hollow iron cylindrical core.

(b) A synchronous motor for rotating the brushes about a fixed commutator.

(c) A set of revolving brushes for collecting the direct current.

### TRANSFORMER.

The core (Fig. 1) of the transformer is built up of sheet-iron punchings laminated at right angles to the axis of the annular ring. It contains uniformly distributed slots parallel to the axis, as in the stator of an induction motor. It differs from the core of an induction motor stator in that the slots are usually not open to the inner periphery, but completely closed. The quantity of iron between the slots and inner periphery being small compared with the exterior portion of the ring, allows an appreciable flux to enter the core of the armature, which rotates within the hollow transformer core. In these slots the coils are placed and the core with its windings is mounted vertically upon a solid frame.

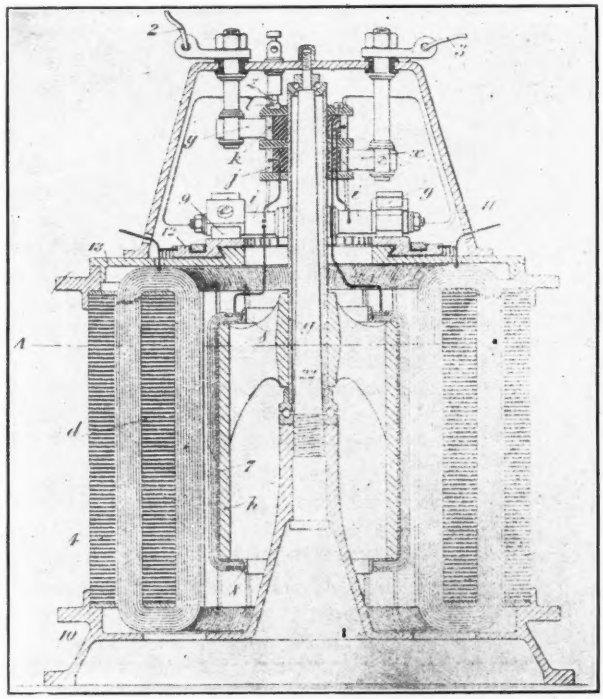


FIG. 1.—CROSS-SECTION THROUGH ROUGE-FAGET PERMUTATOR.

### MOTOR.

The motor, whose armature rotates the brushes about the fixed commutator, is a synchronous motor. Its armature is fixed to a vertical shaft and rotates within the transformer core, thus allowing the use of a small air gap and also preventing unequal wear on the bearings. The core of this armature completes the magnetic circuit of the rotating field, at least that part of the flux which does not remain in the transformer core beneath the slots. The winding on the armature of the brush motor is an ordinary drum winding; in fact, it is the field of the synchronous motor and has been called armature probably incorrectly. It receives its excitation from the direct-current source of the machine through two collector rings. The coils are especially well insulated and in each slot above the coils there is wedged a strip of brass, which holds the coils in place; these brass strips also serve as conductors of a simple squirrel-cage rotor of an induction motor when the machine is being started.

### COMMUTATOR AND BRUSH HOLDER.

The brush holder is fixed relatively to the armature, but capable of angular adjustments about the motor shaft. The brushes are equally displaced about the commutator and rotate at a uniform velocity when the machine is in operation. To eliminate the effects of centrifugal force the brush holder is designed to produce approximately uniform brush pressure upon the commutator for all working speeds. This is of kinematic interest only and needs no further mention except to say that uniform brush pressure is a desirable feature to maintain.

On the upper portion of the core frame is mounted a commutator. It differs in no way from the ordinary type except that commutating resistances are used. Fig. 1 shows a disk commutator with radial segments; this, it may be stated, need not necessarily be the case.

### CORE WINDINGS.

The diagram of the windings of the machine under test is shown in Fig. 2. There are shown ninety slots for the sake of clearness—in reality there are only forty-five, both the external and internal coils occupying the same slots. It is seen that all these coils are alike, each coil consisting of three turns and having a pitch of seven slots. The coils, consisting of three conductors, are connected in series, and for a complete circuit about the core there are four coils, approximately ninety degrees apart. The terminal of the fourth coil is connected to the beginning of the coil adjacent to the first. Thus it is seen that the winding is symmetrical. When

properly supplied with a two-phase current a four-pole rotating field will be produced. These coils the patentees of this machine have called "vectorial" coils or windings; the reason for giving them this name will be evident when we analyze their functions.

In this machine one phase is connected to rings I and II, and the second phase (two-phase machine) is connected to rings III and IV. In the more general type of permutator an independent winding is placed upon the core either in the same or separate slots. To elucidate the actions within the core the general type of permutator will be used as an example.

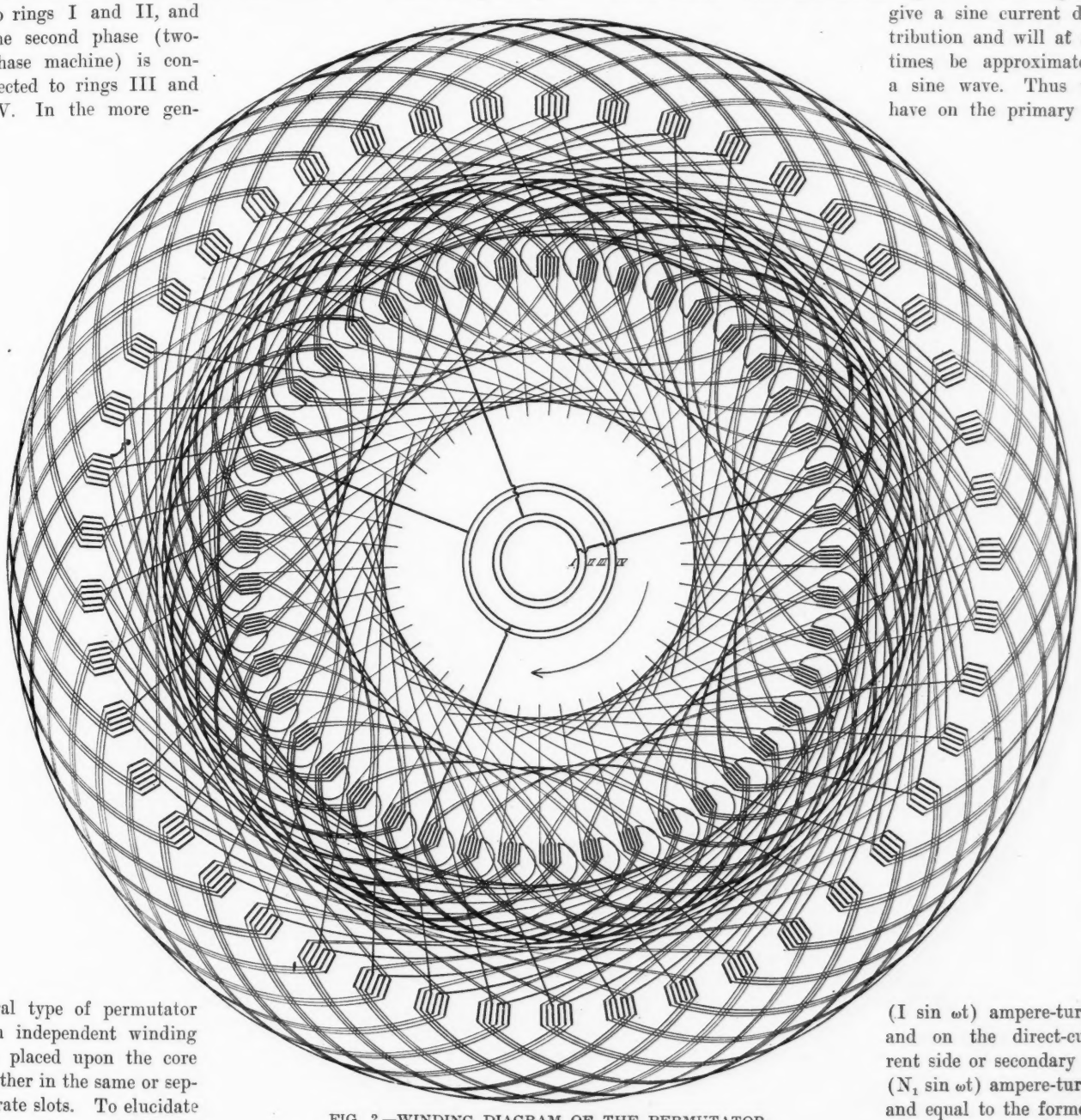


FIG. 2.—WINDING DIAGRAM OF THE PERMUTATOR.

The second winding mentioned in the last paragraph forms the primary winding of the cylindrical transformer core and differs in no way from that of an induction motor stator winding. The potential across the primary coils, as in any transformer, may have any value whatever; the secondary voltage, depending upon the ratio of turns, may be made equal to that value which gives the desired rectified voltage, which is 1.414 times the alternating voltage across the secondary or "vectorial windings."

Since the primary coils are so wound as to create in the core a uniform rotating magnetic field there will be generated in the secondary (vectorial) winding an electromotive-force having a wave similar to the impressed. That is, with a sine wave impressed upon the primary, there will be induced in the symmetrical vectorial windings an equivalent sinusoidal current distribution. The production of a sinusoidal current distribution to prevent electric and magnetic disturbances is brought about by winding the secondary with chord circuits (see Fig. 2). This diagram may represent the secondary with chord circuits. The direct current now circulating in this winding will give a sine current distribution and will at all times be approximately a sine wave. Thus we have on the primary N ($I \sin \omega t$) ampere-turns and on the direct-current side or secondary $I_1$ ($N_1 \sin \omega t$) ampere-turns and equal to the former, where

$N$ = number of primary turns.

$I$ = primary current (maximum).

$N_1$ = number of secondary turns interlinked with the flux, which is interlinked with N.

$I_1$ = direct current.

It is for this reason that these windings have been given the name "vectorial

windings." It is evident that the direct current may now be represented as a vector under these circumstances.

Returning to Fig. 2 attention may now be called to the arrangement of terminal connections, which was heretofore left out of consideration. The angle between the terminals of each phase is 180 electrical degrees and between phases it is 270 degrees or — 90 degrees. Hence, the vector sum of the electromotive-forces is constant and equal to the terminal voltage on the direct-current side of the machine, *i. e.*, $\sqrt{2}$ times the voltage across one phase. This winding, it may be said, is the scheme generally used for the secondary of any permutator. In the winding diagram the direct-current brushes bearing on the commutator are not shown. There are four of them, ninety degrees apart, and opposite ones are connected together. From each set a lead goes to the direct-current terminals of the machine.

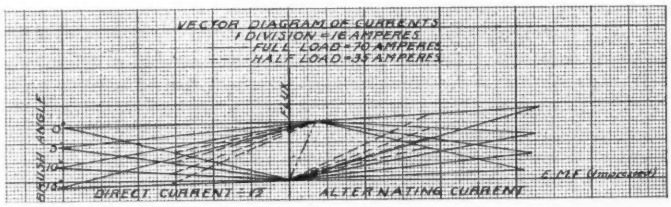



FIG. 3.—VECTOR DIAGRAM OF PERMUTATOR CURRENTS.

OPERATION.

Like a transformer, this machine may be directly connected to the line without serious results within the machine itself; that is, no auxiliary starting device is necessary—the closing of the switch starts the machine and it comes up to synchronism within a few seconds.

When the switch is closed on the alternating-current side the brush motor starts as an induction motor because of the brass strips of the previously mentioned armature. Attention was called to the well-insulated coils on this armature. Ordinarily the circuit of these coils is closed, practically short-circuited; however, since the coils are made up of many turns in series there is danger of breakdowns of insulation due to the high electromotive-forces induced when the switch is closed, should for some reason the armature circuit be open.

At the instant the circuit is closed an alternating current exists on the direct-current side of the machine. The frequency of this current is equal to the product of the line frequency by the slip and decreases to zero as the armature approaches synchronism. The impedance of the armature coils decreasing and becoming equal to the resistance at synchronism, allows sufficient current to excite the coils to cause the armature to fall into synchronism with the rotating field.

To reverse the potential of the direct-current terminals it is only necessary to open the alternating-current switch for a few seconds and again close it. If the brushes differ by 180 degrees (electrical) from their former position with reference to the same portion of the cycle when the switch is again closed, then the desired result is obtained; if not, the operation must be repeated. If the machine is separately excited it is evident that the reversal cannot be brought about by this means.

The parts of the armature which make it a squirrel-cage rotor have been mentioned with reference to the starting action. This rotor also serves as an efficient damping device for the prevention of hunting. To a limited extent the coils of the armature serve the same purpose. It must not be lost sight of that the kinetic energy of the moving system is comparatively small, and because of this fact the damping device is enormously more effective than in any rotary converter. This characteristic is not only advantageous in the machine itself, but also serves admirably when connected in parallel with other machines to prevent an interchange of energy between them.

To appreciate fully the power-factor curves in Fig. 4, it is desirable to explain a few points of interest with reference to the vector diagram in Fig. 3.

In this diagram the impressed alternating voltage is taken as the zero vector and the flux is shown, as indicated, lagging behind the electromotive-force by ninety degrees. The exciting current, as for any transformer, is the resultant current of the secondary (in this case it is rectified) and the primary current. This is true for this machine because the direct current may be vectorially represented as one side of the parallelogram, as shown in Fig. 3. It is evident that the electromotive-force of constant potential is in phase with the direct current, and that the same is true for the terminal voltage. The counter electromotive-force on the alternating or primary side (not shown) differs from the impressed both in phase and in value, due to the posi-

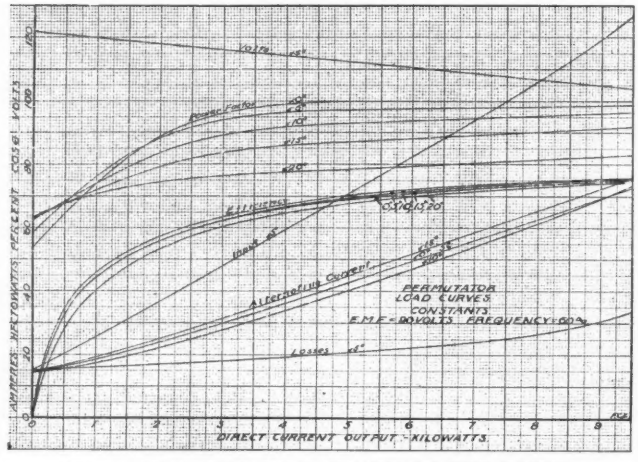



FIG. 4.—CHARACTERISTIC CURVES OF THE ROUGE-FAGET PERMUTATOR.

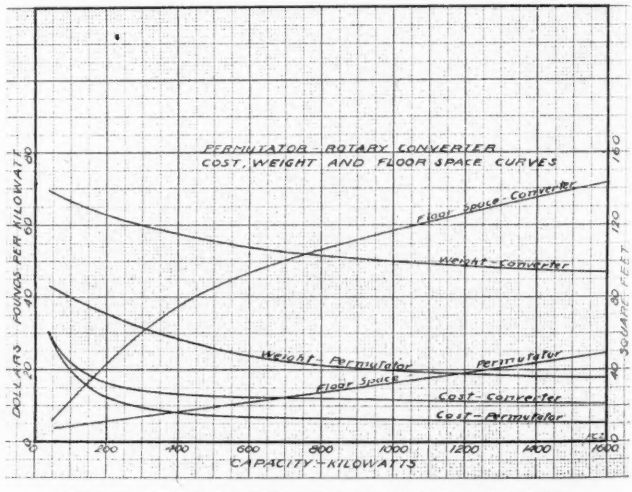



FIG. 5.—COMPARATIVE CURVES OF PERMUTATOR AND ROTARY CONVERTER.

tion of the brushes, inductive drop and copper drop.

The magnetizing current is constant and is represented by the double dot and dash line. Now that this remains constant it is seen that by shifting the brushes in the direction of rotation, that is, clockwise, the direct current furnishes part of the excitation and nearly all with the brush set at zero degree. This necessarily decreases the wattless component of the alternating and thus increases the power-factor. Furthermore, an increase of load also increases the power-factor, very rapidly for small loads and very slowly for large loads, the rate of change depending upon the angle of lead given to the brushes.

Fig. 4 shows the effect produced upon the power-factor by varying the brush lead for any output. The angles given in this figure refer to the reading on a scale. For the curve marked ten degrees the brushes are in the neutral plane, for five degrees they lead by an angle of ten degrees (electrical), etc. The remaining curves in Fig. 4 and also those in Fig. 5 show the other characteristics of this machine. Considering the small size of this machine, one is impressed with the fact that in no wise are these characteristics inferior to those of the converter, except in regard to power-factor variation due to either leading or lagging currents brought about by simply varying the field strength of the converter.

The superiority of the permutator the reader has probably realized from what has already been said. A brief comparison between this machine and the converter in regard to its operating performance, weight, cost, etc., will probably be of interest.

We notice, in the first place, that its starting action is very simple, and when used to feed into a direct-current system simply requires the closing of the supply switch and then the feeder switch after synchronous speed is reached (something like five seconds are required to bring the largest made machine up to synchronism).

If separately excited, which would be the case in general, it will always come up in the right direction. In brief, practically the only apparatus on the switchboard would consist of recording and indicating instruments—all auxiliary starting apparatus being unnecessary.

The curves shown in Fig. 5 give some idea of the relative values of weight, floor space and cost of permutators and rotary converters. The customs duty (foreign machine) is not included in the cost of the permutator, but, on the other hand, the weight and floor space of the transformers, which would have to be used with converters, are not included.

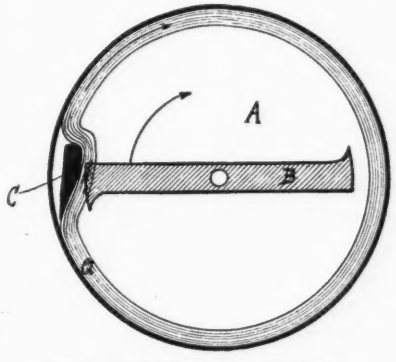
To sum up in tabulated form, the advantages of the permutator are:

(a) Self starting—simple action.
(b) No starting apparatus necessary.
(c) Synchronous speed attained within a few seconds.
(d) Cannot hunt.
(e) Operation simple.
(f) Less attendance required.
(g) Overload capacity large.
(h) Adaptable to frequencies between wide limits.
(i) Transformers unnecessary.
(j) Suitable for any voltage.
(k) Perfect parallel operation.
(l) Small weight.
(m) Low cost.
(n) Small floor space.

These are in brief some of the characteristics of this new rectifying apparatus, the development of which has just begun.

### A New Mercury Interrupter.

The weaknesses of mechanical and Wehnelt interrupters are well known to workers with induction coils. Also, the old form of vibrating mercury interrupter




NEW MERCURY INTERRUPTER.

had a limited capacity. The merit of having extended these narrow limitations belongs to Nikola Tesla and Hans Boas, who first constructed rotating mercury interrupters utilizing a stream of mercury for making and breaking a circuit, says Friedrich Dessauer. A number of apparatus of this type designed by other inventors are described and their defects pointed out. One that has been built by the author and stated to have given most satisfactory results is diagrammatically illustrated in the accompanying illustration. A vessel *A*, rotating around its axis, throws the mercury around in a ring. Contacts *B* are rigidly connected to the vessel. They are shown in the figure as contact rods, but may equally well be constructed in the form of a wheel with metal segments or the like. The number of these segments or contact rods is determined by the frequency of interruption desired. The contact rods are so dimensioned that normally they do not reach the mercury ring. A body *C*, called "knife" or "deviator," which does not move with the mercury, projects into the vessel. The knife may be stationary or it may rotate either in a direction opposite to that of the mercury or with it, but at a lower speed; in the latter case the frequency of interruption will be smaller. The knife has a curved form, so that the mercury flows over it and approaches the contact rods. Assuming, for the sake of simplicity, that the knife is stationary, then the revolving mercury ring will be deformed at one point of its path in such a way that each rotating contact piece will dip into it once each revolution.

It is evident that the knife may be replaced by some other suitable body, as, for instance, a piece which will deflect the moving mercury toward the top or bottom. The principle of the apparatus is that a moving figure of a fluid conductor, as mercury, produced by centrifugal motion is deformed at one or more points in such a way that a solid conductor forming the second contact will make connection with the mercury at these points and effect a make-and-break of the circuit. The quantity of mercury required is said to be very small and its oxidation almost nothing.—*Abstract from the Physikalische Zeitschrift (Leipsic), October 1.*

### Street Telephone Stations on Poles.

A dispatch from New York states that the New York (Bell) Telephone Company has adopted the plan of having pay-station telephones in special boxes installed in the street, like the call boxes used by the police. The idea has been put to a practical test by the Independent companies at Buffalo and elsewhere, and has been found so thoroughly practical that the boxes will probably soon become familiar adjuncts to the service.

Those who have tried the street telephone say that the rumble and noise of the traffic does not cause any particular annoyance, as the head of the person using the telephone is inside the little box in which the instrument is placed.

Not only does the new idea encourage the use of the telephone, but the profit is large, the boxes being placed on the company's own poles, eliminating expense for rent. The directory books are chained inside the boxes.

## LAWS OF ELECTRODE LOSSES IN ELECTRIC FURNACES.—II.

BY CARL HERING.

### CONDITIONS OF MINIMUM LOSS.

For a given normal current at which the furnace is to be operated, it will be noticed from formula (1) that when the heat-conduction loss for no current flowing (the first term), is made equal to half the $C^2R$ loss (the second term), then the two terms are equal, and their sum is therefore equal to the total $C^2R$ loss. It will be shown that this is the condition of minimum loss described above.

For a given length the first term (heat conduction) increases as the section increases and in direct proportion, hence in Fig. 4 this quantity is an increasing one, represented by an inclined straight line *oh*. The second term, however (half of the electrode loss), will decrease as the section increases, and in inverse proportion, hence this quantity is a decreasing one, represented by the hyperbola *ee*.

The sum of two such quantities always has a minimum value, as is shown by the curve *mm*, which represents the sum of the two ordinates, and is therefore the curve of the values of $X$ (in watts) in formula (1). It will be seen that this minimum point is reached when the two quantities are equal to each other, that is, at the point where the two lines intersect. It is therefore at this point that the conduction loss is equal to half of the $C^2R$ loss, which is the condition stated above.

If the same sets of curves be drawn for several other lengths of electrodes, as shown in dotted lines in Fig. 4, it will be noticed that the total loss at the corresponding minimum point always has the same value, namely, the height of the upper curve measured at its minimum point. This means that the minimum loss is determined only by the material, the temperature and the current, and cannot be further diminished by changing the dimensions. It is therefore a fixed quantity, determined by the given conditions of material, temperature and current, and no possible change of dimensions can reduce it. To reach this minimum requires a certain proportion between the length and the cross-section.

Let $mX$ be this minimum total loss in watts. Making the two terms in formula (1) equal, solving for the ratio of $S$ to $L$ and substituting in (1) gives

$$mX = 2.984\ C\ \sqrt{krT} \quad \ldots\ldots\ldots\ldots (2)$$

from which the minimum loss in watts can readily be calculated for any given case. The constant 2.894 is a purely mathematical one, and includes no physical properties.

It is of considerable interest to note that this formula shows that this loss is independent of the dimensions and is fixed by the current, temperature and material ($k$ and $r$); also that it increases in direct proportion with the current and not with its square; and, further, that it is independent of the amount of energy in the furnace, being a function merely of the current, which means that for a given input in kilowatts in the furnace, the minimum total electrode loss becomes smaller if the current is decreased and the voltage increased. For a given normal current, material and temperature, the conditions are fixed, and the electrodes may be determined; the minimum loss, then, of course, applies to this normal current and to none other; for if with the electrodes thus determined the current falls below this normal, the loss will, of course, be less, but so will also be the energy in the furnace. What is said above, of course, applies only to the normal current specified for operating that furnace.

The formula also shows that the minimum electrode loss increases only as the square root of the temperature, and not as the temperature itself, as might at first be supposed. This means that the temperature may be increased considerably without increasing the loss greatly.

The same is true of the heat conductivity $k$ and of the electrical resistivity $r$, either of which must be decreased considerably in order appreciably to better the loss. Hence the choice of material is not as important a factor to reduce the loss as might at first be supposed, and such choice may therefore often be determined by other consideration, such, for instance, as size, convenience in handling, size of water jackets, terminals, etc., all of which will be shown to be far more favorable for graphite, for instance, than for carbon, although the minimum possible loss of energy seems to be slightly greater than for the latter. It will also be found that this minimum loss is in most cases quite small, much smaller perhaps than is generally supposed, hence a further reduction by reducing any of the determining factors in formula (2) should be carefully considered with respect to any possible attending disadvantages, chiefly as to size, as it may not be worth making. To reach this minimum loss with carbon, for instance, requires the electrodes to be far larger in section than for graphite (for a given length), and if not made of this much greater size the loss will not be the minimum, and hence may then exceed that of graphite. The differences between the minimum losses in these two materials (provided the best proportions can be realized in practice, which may not always be the case with carbon) does not seem to be great, yet the difference in the size is very great.

Another feature to be considered is, that in high temperature furnaces carbon may graphitize partly, and if it was correctly proportioned at first, it will evidently not be so later on, hence the loss will then become greater again. Graphite is stable and does not change, hence if correctly proportioned at the start, it remains so.

The resistivity $r$ may be replaced by the reciprocal of the electrical conductivity $K$, and for comparing the qualities of materials as such, the current and temperature may be made unity. The result will then represent the loss in watts per ampere for one degree of temperature, and will therefore be characteristic of the material itself. Making these substitutions gives

$$mX' = 2.894\ \sqrt{k/K} \quad \ldots\ldots\ldots\ldots (3)$$

where $K$ is in reciprocal ohm (mho), cubic-inch units.

This shows the interesting fact that the minimum loss depends on the ratio of the two conductivities—both may be large or both small and yet give the same result as far as the loss is concerned. The smaller this ratio, the better the material, as far as the minimum loss is concerned. Moreover the loss varies with the square root of this ratio, which must therefore be considerably diminished in order to reduce the loss materially.

In order to improve materials for electrodes when this minimum loss is the criterion, the electrical conductivity should be increased as much as possible, and the heat conductivity diminished as much as possible; but it is their ratio that is the deciding factor, hence the heat conductivity may even be increased and yet the ratio may be less, if the electrical conductivity has increased still more in proportion.

There is still another interesting feature about this minimum loss. The loss represented by the formula (2) is also equal to $Ce$, in which $e$ is the drop of voltage in one electrode. Making this substitution gives

$$e = 2.894\ \sqrt{krT} \quad \ldots\ldots\ldots\ldots (4)$$

which is seen to be independent of the current, and which therefore means that

for every material ($k$ and $r$) there is a characteristic minimum drop of potential in the electrodes for one degree of difference of temperature, below which voltage it is not possible to go without again increasing the total loss; and this is independent of the capacity, the dimensions, and even the amount of the normal current, the total drop being dependent only on the temperature. It might be termed the "electrode voltage" of that material, as it is a characteristic property of it as an electrode material.

If by the term "electrode efficiency" is meant the voltage between the two inside or hot ends of the electrodes, divided by the voltage between the two outside ends, its highest possible value is determined by the total voltage of the furnace, the temperature and the material, and is independent of anything else. Hence for any given electrode material and temperature drop, the furnace voltage necessary to give any desired electrode efficiency may readily be calculated.

This minimum electrode loss is not merely a theoretical ideal which it is impractical to reach, but it is an eminently practical result which could probably be readily reached in most furnaces, with graphite, at least, if not with carbon also, when the data for its proper determination, namely, the two conductivities, exist. Attention should, however, be called to the flatness of this minimum curve *mm* near its minimum point, which means that great accuracy in the proportioning is not necessary, as slight variations in the proportions in either direction will make only a small difference in the total loss. For instance, in the case shown in Fig. 4, a change of ten to twenty per cent in the cross-section near the minimum point will increase the loss only about one to three per cent.

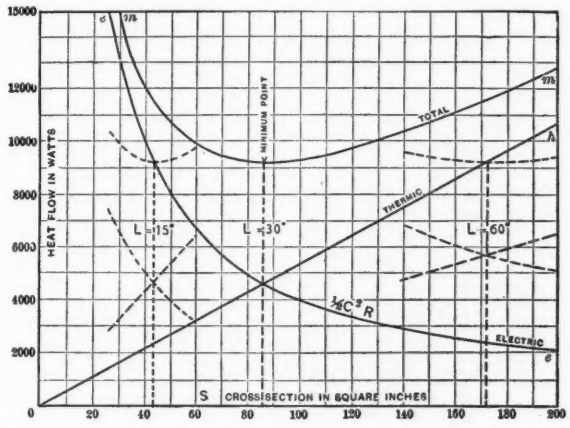



FIG. 4.

PROPORTIONS AND ECONOMY OF THE ELECTRODES.

Although the absolute dimensions of the electrodes are not fixed by the conditions for obtaining the minimum loss, yet the relation of the section to the length is. This is best shown analytically. If the two terms in formula (1) are made equal, which is the condition of minimum loss, the ratio of $S$ to $L$ is found to be a constant, determined by the material ($k$ and $r$), the temperature and the current. That is, when

$$4.186\ kT.\ \ S/L = C^2r/2.\ \ L/S \text{ or,}$$
$$S/L = 0.3456\ C\ \sqrt{r/kT} \ldots\ldots\ldots\ldots (5)$$

This means that to get the minimum loss under given conditions of material, current and temperature, the cross-section must merely bear a certain relation to the length as given by this formula. The interesting conclusion from this is that any number of different electrodes will give the same result, as illustrated in Fig. 5, in which all have the same ratio of section to length, as required by formula (5). The cross-section in all these is ten times the length in inch units. It thus leaves one a choice of either the length or the section, but not of both, and this choice does not concern the loss of power—it merely affects the economy of electrode material. Practical considerations usually determine the length, and it is therefore generally the cross-section which is to be determined from formula (5).

Notice should be taken of the fact that the numerical value of this ratio will be different for different units, as, for instance, for inches and for centimetres; the actual sizes will, however, of course, be the same.

The rule concerning the economy of electrode material is therefore simply: Make the electrodes as short as practical considerations will permit. As the cross-section also diminishes with the length, the volume, or approximately the cost in dollars diminishes as the square of the length. Hence the great importance of making the electrodes as short as possible, when the economy of the electrode material is of importance; this choice of length will not affect the power loss, and can therefore be decided on its own merits and without regard to the power efficiency.

For a given length the formula may be written in the form

$$S = 0.3456\ CL\ \sqrt{r/kT} \ldots\ldots\ldots\ldots (6)$$

which means that for a given length, temperature and material, the section increases in direct proportion with the current; hence the importance of producing the required heat in the furnace by as high a voltage as possible, so as to diminish the normal current. This will not only make the electrodes smaller in the direct proportion as the current is diminished, but, as previously shown, it also diminishes the lowest possible loss of power in the electrodes; hence it is a double gain.

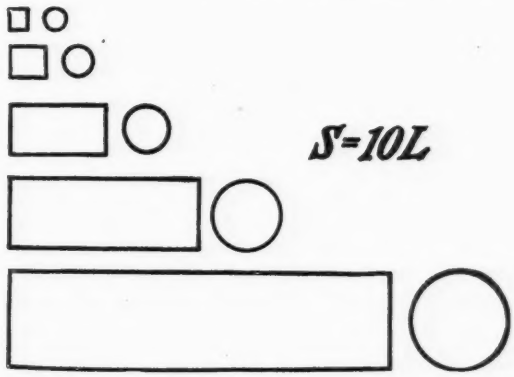



FIG. 5.

It will be noticed from (6) that the section diminishes as the square root of the temperature, that is, for higher temperatures it becomes smaller.

Letting the current density in amperes per square inch be represented by $Cd$, then formula (5) reduces to

$$Cd = 2.894/L\ \sqrt{kT/r} \ldots\ldots\ldots\ldots (7)$$

which shows that the proper current density to obtain the best possible proportions varies inversely with the length, and therefore directly as the section; hence it is quite incorrect to proportion electrodes on the basis of a fixed current density, as is often done. For any assumed length the resulting current density can readily be calculated from this formula so as to compare it with the maximum which the material will stand; if water-cooled at one end, it will stand much more; hence

water-cooling results in an economy of material.

Making $C$ and $T$ equal to unity in formula (5) gives

$$S/L = 0.3456 \sqrt{r/k} \quad \ldots\ldots\ldots\ldots\ldots (8)$$

which shows that per ampere and for one degree temperature there is a definite best proportion of section to length for each material which is a characteristic of that material and below which it is not possible to go in economizing without increasing the loss. Hence this figure affords a good means of comparison of different electrode materials when the economy of the material is the criterion. It shows that in this respect graphite is far superior to carbon, as electrodes of the former are very much smaller, as will be shown later.

Substituting in (8) the electrical conductivity $K$ for the resistivity $r$, as was done in formula (3) for the convenience in making comparisons, this formula (8) reduces to

$$S/L = 0.3456 \sqrt{1/Kk} \quad \ldots\ldots\ldots\ldots\ldots (9)$$

This shows that, as far as economy of material is concerned, that material is best in which the product of the two conductivities is greatest. Hence, to improve a material in this respect either or both should be increased. But the improvement in economy is only in proportion to the square root, and hence is not as great in percentage as the improvement in either of the conductivities.

Comparing this formula (9) with the corresponding one (3) for the minimum loss, it will be noticed that the requirements for economy in material (9) and for economy of power (3) are different, and in some respects antagonistic, hence the choice of the material depends somewhat on the relative importance of these two economies. With graphite and carbon, for instance, according to the best, though crude, figures available for the two conductivities, the electrodes become much smaller for graphite, but the minimum loss is slightly less for carbon, provided both have their best proportions and, of course, the same length.

In this comparison of (3) and (9) it will be seen that both economies are improved by an increase of the electrical conductivity alone; hence this is always desirable. An increase in the heat conductivity alone improves the economy of material, but diminishes the economy of power; a decrease in the heat conductivity alone improves the economy of power, but increases their size. The final criterion depends on their quotient and product, as was described.

In formulas (5), (8) and (9) the relation is stated in the form of section divided by length; this was done because practical considerations usually fix the length, and it is therefore cross-section which remains to be calculated. By inverting these formulas so as to give the ratio of the length to the section they become more similar to (2), (3) and (4), with which they can then be better compared for making any further deductions.

RULES FOR DESIGNING ELECTRODES.

From the above the rules for the guidance of the designer may be briefly summarized as follows:

The temperature and the kilowatts are always given in the problem. The two conductivities or resistivities of the proposed materials must, of course, be available. From the kilowatts make the current as small and the voltage as high as practicable. From formula (5) calculate the proportion of the section to the length. The length is generally fixed by the width of furnace walls or other considerations; the only rule is to make it as short as practicable; this length then determines the section. The current density (7) is not a factor in calculating the proportions of electrodes except, insofar that it should not exceed practicable limits.

The electrode loss will then be the minimum possible, and is determined from formula (2) in watts; this is for one electrode and must therefore be multiplied by 2 to get the total. The electrode efficiencies are then readily determined.

These calculations should be repeated for each of the different materials available and the various advantages and disadvantages due to their different sizes, losses, terminals, etc., should be carefully weighed.

Never compare two electrodes of the same size but of different materials having different conductivities; such a comparison is unjust to either one or the other or both, as also to the designer, because it gives him an unwarranted confidence. They can be properly compared only when both have their best proportions.

In the concluding portions of his paper the author illustrated his method by numerical examples, and proceeded finally to an analytical proof of the fundamental equation, etc.

## Electric Smelting Costs in Sweden.

In a recent report from Stockholm, Sweden, to the Canadian Department of Mines, Sir Cecil Spring-Rice makes the following statement regarding the development of electric smelting in Sweden:

Arrangements have been made with the Trollhatten Water Power Company for the construction and working of three electric furnaces for the production of pig iron. Each furnace is to receive a current of 2,500 horsepower and to produce 7,500 tons per furnace per annum. Two are to be in working, while the third is in reserve. The price of the current per horsepower per annum is 27.60 kroner for the first ten years, and 36.80 kroner the next ten. The ore is to be brought from Grängesberg, containing from 0.4 to 1.9 per cent phosphorus. Westphalia coke will be used, costing about twenty-one kroner at Trollhatten. It is calculated that the cost of production will be fifty-one kroner per ton pig iron. The sale price is fifty-eight kroner. With a production of 15,000 tons per year, the cost is calculated as follows:

| | Kroner. |
|---|---|
| Three furnaces | 150,000 |
| Tools, etc. | 15,000 |
| Crushing apparatus for 35,000 tons ore and 7,000 tons coke | 9,000 |
| Electric motors, lighting, etc. | 6,000 |
| Transport of ore and coke from harbor | 15,000 |
| Transport of pig iron and slag | 12,000 |
| Houses and shelters | 64,000 |
| Harbor works, leveling, etc. | 15,000 |
| Laboratory, unforeseen, etc., 11 per cent. | 20,000 |
| License | 34,000 |
| Working capital | 25,000 |
| Minimum capital | 235,000 |
| Total | 600,000 |

The value of the Swedish krone is given in Webster's New International Dictionary as $0.268.

## The Most Powerful Ship Yet.

The British Admiralty is still leading the way in naval construction, as is evidenced by the announcement that the new cruiser about to be laid down at Devonport (Eng.) Dockyard will be equipped with turbine engines of no less than 70,000 indicated horsepower! The designed speed of this ship has not yet been made known to the public, but the *Invincible*, the fastest cruiser in the world at present, can make over twenty-six knots with her engines of 41,000 horsepower, so it can safely be assumed that the speed of the new vessel will be phenomenal. It is understood that the armor, armament, displacement and electrical equipment of the new cruiser (the first of a number provided for by the present plans) will be in keeping with the horsepower.

## Wireless Opportunity.

An American consul in an Asiatic country reports that a local government official has made inquiries concerning the possibility of installing a wireless-telephone system. A system such as is used on lake steamers in the United States would undoubtedly give satisfaction, and the consul states that if installed by an American would increase American influence in that region very much. He adds that he is willing to give this matter his personal attention and would like to hear from American firms in regard to the same. Further information can be obtained by writing to the Bureau of Manufacturers, Washington, D. C., quoting File No. 4133.

### Cadmium Amalgams and the Weston Normal Cell.[1]

A number of researches have been made within recent years on the electromotive properties of mercurous sulphate, and as a result it is possible to make a standard cell having considerable accuracy. There are still many instances withal of abnormal behavior of such cells both as to constancy of electromotive-force and with respect to change of electromotive-force with varying temperature. The want of constancy has been attributed to slow hydrolysis of the mercurous sulphate, and to a change in the size of the mercurous sulphate crystals. Irregular behavior with changing temperature has been observed by several investigators, all of whom attribute the observed differences to the cadmium amalgam.

While the exact constitution of cadmium amalgams is doubtful, there is no doubt that the electromotive properties of the amalgams depend largely on whether one or two phases are present. When, by increasing the temperature, a solid amalgam is converted into a mixture of liquid and solid phases, there is an immediate change in the electromotive temperature coefficient of the amalgam, and a similar change results when the co-existing phases are changed entirely into the liquid state. If the temperature of an amalgam, containing the mixed phases, is raised, the liquid phase is increased and the solid phase diminished. It is probable, however, that the electromotive-force of an amalgam toward a solution of cadmium sulphate does not depend on the relative amounts of the two phases. Hence, amalgams containing different percentages of cadmium, but possessing the two phases, may have the same electromotive-force toward a cadmium sulphate solution. With amalgams all solid or all liquid, the electromotive force varies with the cadmium content.

The objects of the present investigation were: (1) To trace the cause of the electromotive difference, which sometimes existed, and which was sometimes absent, between ten and twelve-and-one-half per cent amalgams; (2) to determine the limits of temperature between which amalgams of various concentrations could be usefully employed; (3) to explain the abnormal electromotive-forces of cells made by various observers, when the amalgams contained from twelve-and-one-half to fourteen per cent of cadmium; (4) as the recent International Conference on Electrical Units and Standards specifies a twelve-and-one-half per cent amalgam, it was important to decide whether the limits of temperature (zero to forty degrees centigrade) specified, required amending or not.

The author's conclusions are as follows:

1. Cadmium amalgams of such a composition that if homogeneous—the term is used in a relative sense—they would be completely solid below certain temperatures, may not in a Weston normal cell have that electromotive force toward a cadmium sulphate solution corresponding to such a solid. The general result is a lowering of the electromotive force of the cell and is due to lack of homogeneity of the amalgam, the outer skin of which is of low cadmium concentration and the center of the mass of high cadmium concentration. Diffusion tends to restore uniformity, and in consequence the cell is unstable for a very considerable time—the electromotive force rising.

2. When the amalgam is at a temperature near to, but below, the first transition point, the difference of concentration between the inner and outer parts of the amalgam need be only small to enable the outer skin to be a two-phase system. Owing to the small difference of cadmium concentration throughout the mass the diffusion process will be slow and the electromotive force of the cell may remain constant for a very long time. There is, however, in general, a small difference in electromotive force between such a cell and one containing a normal two-phase system.

3. Cadmium amalgams of such a composition that, if homogeneous, they would be all liquid above certain temperatures, may not in a standard cell have that electromotive force toward the solution corresponding to a homogeneous amalgam. In such a case the electromotive force of the cell is higher than usual. The effect is due to the upper part of the amalgam being a two-phase system and the lower part an all liquid system of less cadmium concentration than the upper part. Diffusion quickly equalizes the concentration and the electromotive force falls to a normal value.

4. The twelve-and-one-half per cent cadmium amalgam at present used in the Weston normal cell may be completely solid at temperatures below twelve degrees centigrade, and cells containing it may have a higher electromotive force than normal if used below that temperature. Fortunately, even at temperatures such as zero centigrade, the amalgam is comparatively near to its first transition point, and the conditions are similar to those noted in (2). In consequence, except in rare cases, cells containing the twelve-and-one-half per cent amalgam will behave at zero temperature (centigrade) as though they contained an amalgam which was always in a two-phase system at that temperature.

5. As a ten per-cent amalgam at zero centigrade is above its first transition temperature this may be used in standard cells at low temperatures. Such cells may also be used at temperatures as high as fifty-one degrees. We suggest that the twelve-and-one-half per cent amalgam in the Weston normal cell be replaced by a ten per cent amalgam.

[1] Abstract of a paper by F. E. Smith, presented at the October 23 meeting of the Physical Society of London (Eng.).

### New Telephone Line in South America.

The Union Telephone Company, of Buenos Ayres, is about to build a telephone line from that city to its leading seaside resort, Mar del Plata.

### An Electromagnetic Friction Coupling.

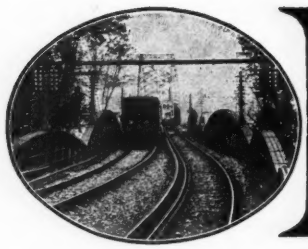
This coupling, which has been patented in Germany by a machine-building firm of Berlin, is intended chiefly for motors and rolling mills. Its two principal parts are an electromagnet in the form of a pot mounted rigidly on one shaft, and the armature of this magnet mounted on the other shaft in such a way that it can be displaced. Current is transmitted to the coil of the pot-shaped magnet by means of two collector rings and brushes. When the circuit is closed the two parts of the coupling attract each other strongly, but without being able to touch, a direct contact being prevented by friction rings arranged on both sides and consisting of non-magnetic material. The frictional resistance thus produced causes the rotation of the part to be operated. When the circuit is opened the magnetic action ceases immediately and the two parts of the coupling are separated from each other by springs. Switches for operating the couple may be located in different places in order to diminish the danger of accidents. The various parts are easily interchangeable. The current consumption is small, being only one-half to one ampere at 220 volts for models of the size most extensively employed.—*Translated and abstracted from L'Electricien (Paris), October 23.*

### A Reversible Turbine.

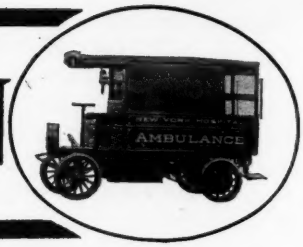
Consul Frederick I. Bright, of Huddersfield, Eng., quotes a British newspaper statement that an Italian engineer has invented a reversible turbine engine. The advantages claimed for the engine are that "there are no blades or vanes to break or get out of order;" that "it will work with equal power or speed in both directions, forward or reverse," and that "it can be built in all sizes from five horsepower to 50,000 horsepower." It is reported that a large company is to be formed, backed by prominent Italians in London.

### The Telechronometer.

A Rochester (N. Y.) man has recently invented a device called the "telechronometer," which is designed to be attached to a telephone instrument to record the length of the conversation by intervals of a quarter of a minute. No record is made when a call is not effective, and furthermore, when a subscriber is called, his meter does not register unless by previous arrangement with "central." Thus the charge is made on the party who is willing to pay for it.



# ELECTRIC TRACTION




## A Modern Electric-Railway Substation.

Probably no other city has been handicapped in its growth to such an extent or encountered difficulties, due to traction problems, as has Chicago. Prior to the year 1907, such chaos reigned that a concise account of traction conditions then would be hard to relate. In February of that year, however, the City Council passed ordinances authorizing the Chicago City Railway Company and the Chicago Railways Company, the latter succeeding the Chicago Union Traction Company, to reconstruct, maintain and operate a system of railways according to the specifications contained in the ordinances. This action was the actual beginning of the rehabilitation of the street railways in Chicago.

One of the first problems to be considered was the changing of power on all remaining cable lines to electricity, some few of these lines having been electrically operated prior to the passing of the ordinances. This change required a great expenditure of money for additions to power stations or new plants, and on account of the financial conditions then existing the Chicago City Railway Company found it more advantageous to abolish its few inadequate power stations and to purchase current from the local central-station company. The Chicago Railways Company having more modern power stations found it necessary to purchase only a part of the total current required.

Since that time the traffic of both railways has steadily increased, necessitating the construction of more substations along their lines. As an example of the most modern practice in substations, the Lill Avenue station, known as Substation No. 3 of the Chicago Railways Company, is selected as being typical. This substation is located on Lill Avenue, near Sheffield Avenue, directly south of one of the new car houses of that road. The building, a substantial pressed brick and concrete structure with steel frame construction and tile roof, is ninety-three feet long and forty-nine feet wide.

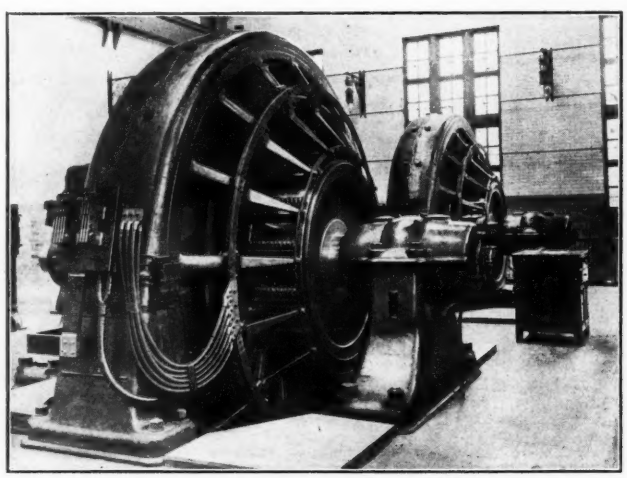
It is divided into a basement of concrete construction and a main or service floor, provision being made for ample space for the operation of the machinery and for light and ventilation.

The entire equipment consists of standard apparatus, including motor-operated oil switches, single-phase air-blast transformers and six-phase compound-wound rotary converters. The substation receives twenty-five-cycle, 9,000-volt, three-phase current from the feeders of the Commonwealth Edison Company, and delivers a 600-volt direct current to the direct-current feeder system of the road.

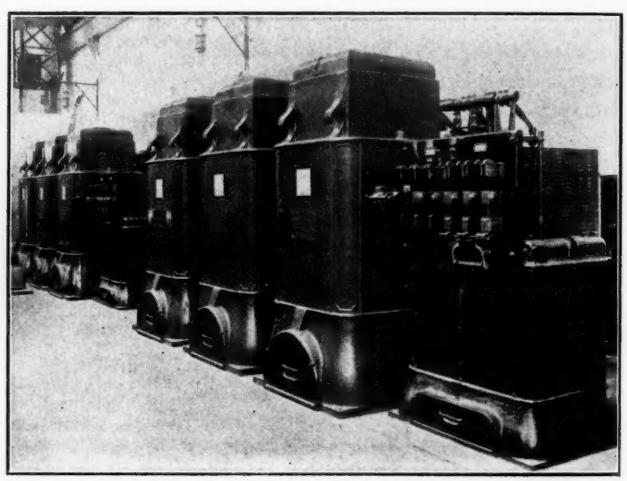
The three-phase current is supplied to the step-down transformers through a separate high-tension underground lead-armored feeder cable. Each transmission line runs through a conduit in the basement to a motor-operated oil switch and is connected through it to a short busbar. To this busbar two other switches are connected, one making connections to the bank of transformers and the other connecting to a transfer busbar which extends through the entire station, but which is divided into three sections through two additional oil switches. An emergency line is connected to the middle section of this busbar. This arrangement provides for great flexibility in the operation of the station.

The apparatus is conveniently arranged in rows. Starting at the west side of the building may be seen the high-tension potential transformers and their detachable fuses, located in small brick structures protected by wood and glass swinging doors. The high-tension oil switches enclosed in brick structures with stone-slab partitions and sliding asbestos doors with glass panels are arranged in a single row in front of the potential transformers. The two banks of 750-kilowatt step-down transformers constitute the next row, the reactance coil for each rotary being placed at the head of each row of transformers. In the next row, with ample space between, are located the two rotary converters; a third one is now being installed. Along the east wall is the main switchboard.

This board contains twenty-four panels of black enameled slate and two auxiliary



VIEW OF 2,000-KILOWATT ROTARY CONVERTERS.



TRANSFORMERS AND REACTANCE COILS.

panels. There are three direct-current converter panels, three alternating-current converter panels, three alternating-current line panels, one battery panel and fourteen feeder panels. The direct-current converter panels are equipped with automatic circuit-breakers, direct-current ammeters and direct-current recording wattmeters; the three alternating-current rotary panels are equipped with power-factor indicators, alternating-current voltmeters and ammeters and inverse time-limit relays. The alternating-current line panels are equipped with wattmeters, line meters and relays. The battery panel is equipped with a voltmeter, an ammeter, two circuit-breakers and a relay for ringing the emergency bells. All feeder panels

VIEW OF SWITCHBOARD IN LILL AVENUE SUBSTATION.

are equipped with ammeters and automatic circuit-breakers. The board is also provided with two direct-current voltmeters on swinging brackets located at each end of the board. Each feeder panel and the machine panels are equipped with lightning arresters located on the back of each respective panel. Back of each alternating-current panel is a potential transformer for the power-factor indicators and voltmeters.

Most of the space in the basement is occupied by a large air chamber in which a pressure of one-half an ounce to the square inch is maintained for cooling the transformers and reactance coils. The air is supplied by three fans direct-connected to seven-and-one-half-horsepower induction motors. These motors are controlled from a three-panel switchboard which is so connected that two motors may be used for operating one fan. The incoming lines and high-tension busbars are also located in this air chamber.

In a room just south of the air chamber is an auxiliary storage battery which supplies current for controlling the oil switches and for the signal lamps on the switchboard. This battery consists of fifty-five cells. In the basement there is also located an automatic pump driven by a Roth motor, this pump being used for drainage purposes.

The building is illuminated by ten arc lamps, five connected in series across the 600-volt direct-current circuit, and also by incandescent carbon lamps, five in series. The lighting circuits are controlled from a panel in the north end of the basement. Included in the apparatus in this station is an electric traveling crane manufactured by the Walker Manufacturing Company.

The entire electrical equipment, with the exception of the motor operating the automatic pump, was supplied by the General Electric Company.

### New York Subway Profits.

In a synopsis of a report of the Interborough Rapid Transit Company of New York given out by the Public Service Commission, the rather interesting point was brought out that there has been a profit of more than three cents per passenger on the subway. The synopsis shows that 237,451,171 passengers were carried at a total expense of $4,547,620.

## THREE-PHASE TRACTION SYSTEMS.

BY FRANK KOESTER.

The practicability of three-phase traction systems has been discussed by our American engineers for a number of years and great efforts have been made to introduce this system here after its having been successfully applied on the Continent of Europe, particularly in Italy and Switzerland. The credit is largely due to Koloman von Kando for applying three-phase current to heavy electric traction. It is probably still fresh in the minds of most readers that in September, 1902, the entire steam locomotives of the sixty-six miles of the Valtellina Railway in upper Italy were supplanted by three-phase locomotives, hauling local and express passenger, as well as heavy freight trains.

The Ganz Company, by whom this installation was carried out, experimented with the three-phase system as early as 1895, and soon thereafter, in 1898, installed a short line at Evians-les-Bains, on Lake Geneva, which was but 0.3 kilometre long, the steepest grade being 10.2 per cent. This was followed later by the introduction of this system for railways in mines in Hungary and France.

These Valtellina Railway locomotives draw three-phase current at 3,000 volts, fifteen cycles, from two overhead conductors, the rails acting as the third phase. The first locomotives were equipped with four 225-horsepower motors, flexible-link-connected to the drivers, having a constant speed of 128 revolutions per minute, and giving a train sped of 18.6 miles per hour. They weighed forty-seven metric tons. The later locomotives, put in operation in 1904, were designed for two normal speeds, namely, one speed 18.5 to 21.5 miles and another thirty-seven to forty-three miles per hour, and weighed sixty-two metric tons. While in the earlier type the motors were mounted on quills surrounding the driven axle, in the later type two motors are mounted between three axles and connected to them by means of cranks and connecting rods, the cranks of the motors being also interconnected. Each motor has a nominal rated capacity of 600 horsepower; hence the locomotive at standard full speed is developing 1,200 horsepower.

In 1906 a similar system was supplied for the Italian State Railway, the locomotive having three speeds instead of two, namely, 15.6, 26.5 and forty miles per hour, the motors having one speed corresponding to eight poles and another to

twelve poles, and the independent connection of the motors and the cascade connections of both enable the three different speeds to be attained. The rated capacity of the motor with eight poles is 1,500 horsepower, that of the twelve-pole motor is somewhat smaller.

The original equipment of the Valtellina Railway included also ten motor cars for passenger traffic, each having a weight of fifty-three tons and generally hauling five trailing coaches with a total train weight of 150 tons. The speed is forty miles and twenty miles, the latter being used at the stations. Each motor car is equipped with four motors transmitting the power to the spokes of the wheels by means of elastic-link couplings. Two motors are wound for 3,000 volts and two for 300 volts, the former being capable of developing 150 horsepower each at 300 revolutions per minute.

Another prominent three-phase traction system is that of the Simplon Tunnel Railway, a road which has a length of 13.75 miles, of which 11.5 miles is in the tunnel proper. While the average grade is 0.7 per cent, there is a grade, on a short stretch of one per cent. The current is taken at 3,000 volts and sixteen cycles from two overhead conductors by bow collectors, the rails constituting the third phase. The earlier locomotives, which were put in operation in June, 1906, were designed for two different speeds, namely, twenty-one and forty-two miles per hour. The change in speed is accomplished by changing the number of poles in the rotor, sixteen and eight poles being used, respectively, for the speeds mentioned.

The new locomotives[1] for this tunnel railway are designed for four different speeds, the change being accomplished in the same manner, depending upon the number of poles used, namely, sixteen, twelve, eight and six, the speeds produced thereby being 16.5, 21.7, 33.1 and 43.4 miles per hour.

Both types of the Simplon locomotives are driven by motors which are link-connected to the drivers, the motors themselves being interconnected. Each of the motors for the new type of locomotive is rated 650 horsepower, while those of the older type were 450 horsepower.

None of the European locomotives have gear-connected motors, and all use, for drawing the current from the working conductors, collector bows or long contact tubes, the two tubes, for the two conductors, being mounted on a single frame.

Fully seven years after the successful operation of the first prominent three-phase system in Europe we come across the first three-phase system in this country, at the Cascade Tunnel of the Great Northern Railway Company. An exceptionally good paper on this installation was presented by Dr. Cary T. Hutchinson at the last meeting[2] of the American Institute of Electrical Engineers.

In addition to other novel features, we find the locomotives used here to be equipped with four motors, twin-geared to the four driving axles in the ratio of 1:4.26. The synchronous speed of the motor is 375 revolutions per minute, giving a speed of 15.7 miles per hour at no load, dropping to fifteen miles per hour at a load corresponding to the one-hour rating. The trolley voltage is 6,000, twenty-five cycles, and drawn from two overhead lines by two collector wheels. As the motor winding is for 500 volts, the potential is stepped down by means of two three-phase transformers. Taps are also provided to draw 625 volts. The motors have a continuous output of 375 horsepower, at 500 volts with 1,500 cubic feet of air supplied per minute for cooling, and 400 horsepower at 625 volts with similar cooling. For the one-hour rating at 500 volts the output was found to be 475 horsepower. The total weight of the locomotive is 230,000 pounds.

At the time efforts were made to introduce the three-phase traction system into this country, about five years ago, much opposition was met with, particularly among the single-phase enthusiasts. It developed at the discussion of the paper referred to that, after six years of argument, the many advantages of the three-phase system must be acknowledged. It had been claimed that the use of two trolleys instead of one and the constant-sped motors instead of variable-speed motors (single-phase or direct current) were the great disadvantages in three-phase traction. It is admitted that a single conductor may cause half the trouble that might be caused by a double conductor, but this is only a matter of detail. The constant-speed motor, particularly in mountainous districts, has the decided advantage of regenerating current in descending the mountain, cutting down materially the required output of the generating plant. As cited in the examples given of the Valtellina and the Simplon Tunnel railways, both of which are for heavy traction, freight and passenger, provision may be made for securing various speeds by cascade switching, changing the number of poles, and changing the secondary voltage of the step-down transformers on the locomotives.

[1] See the illustrated article describing these locomotives in the ELECTRICAL REVIEW AND WESTERN ELECTRICIAN of November 13, 1909, pages 938-940.

[2] See the comprehensive report of this meeting in the ELECTRICAL REVIEW AND WESTERN ELECTRICIAN of November 20, pages 981-985.

### Device for Preventing Collisions.

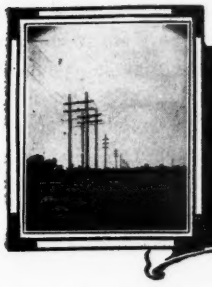
A device for preventing collisions of trains was recently given a test before railway officials of the Erie Railroad in New York, and apparently worked successfully.

Two special trains approaching each other at a speed of thirty miles an hour were stopped within a short distance of each other without the assistance of either engineer.

The invention is operated by a third rail, such as is used on electric railroads. A shoe from the locomotive touches the rail and receives power through it both for the operation of the emergency brake and for the telephone. The principle is similar to that of the block-signal system. A length of track is divided into zones, and so long as only one engine is in this zone a green light shines in the locomotive cab. Whenever two trains enter the same zone, however, this light goes out automatically, and when the trains approach within a given distance of each other the air brakes on each are set automatically. It is possible to arrange the mechanism so that the brakes will be applied with great speed, or so they will operate gradually.

### Increased Earnings of Wisconsin Railways.

The final assessment of the street railway and light, heat and power companies of Wisconsin, recently made by the state board of assessment, shows an increased valuation of nearly $3,000,000 over that of last year. The taxes which will be received from these companies will amount to $422,015.21. Eighty-five per cent of this tax goes to the towns, cities and villages where the properties taxed are located, and the remaining amount to the state. The state will receive $63,302.32 as its share, while $358,712.89 will go to the municipal corporations and villages. The Milwaukee Electric Railway Company will pay a tax of $249,763.46. The Janesville Street Railway Company will pay only $422.94, the smallest amount. Of the $8,001.59 to be paid by the Southern Wisconsin Railway Company, operating in Madison, Wis., $6,801.35 will be paid to the city. M.



# CENTRAL-STATION PRACTICE

## Transmission—Interior Wiring

**Notes on Long-Distance Transmissions.**[1]

When power-transmission work first began in California, the various companies which harnessed the high-fall mountain streams had no idea of becoming linked together, and so each engineered its proposition in its own way.

The importance of the industry has, however, grown to such an extent that a few years ago some far-sighted engineers and financiers saw the advisability of linking up, so that each station could help the others in emergency and also for the purpose of economizing establishment charges. This has now been done.

The result is that stoppages of power are very seldom heard of, and when even only a few miles of steel-tower line are blown down, a way around is found in a few hours.

California is now practically a huge switchboard, with over 1,000 miles of high-tension busbars criss-crossing it in all directions. For the present the voltage is 60,000, but everything now going in is being erected with a view to changing over to 100,000 volts.

In Canada and in India there are some big transmissions already, and more being erected and proposed.

The development of long-distance power has been the means of enhancing the importance of the occupations of patrol men and extra high-tension line repairers. These men have an adventurous life, for they live most of the time away from their fellows and have to ride many miles a day over rough country and in all weathers. If need be, they must be prepared to camp out where darkness finds them and forage for their food as they go along. They can speak with the power house, but a telephone line running parallel to a transmission line is not a nice thing to talk through, however much the two may be transposed.

When the patrol man has discovered a fault, he rings up the power station or substation, and a gang of extra-high-tension line repairers come out. These men literally take their lives in their hands, for it is becoming the custom to execute all repairs by daylight, when current is on the line. It can be done quicker that way, and there is no loss of revenue due to the line being stopped.

It is with a feeling of relief that one reads that special clamps have been invented to fasten high-tension wires to insulators, so that winding thirty inches of the wire with sticks three feet long will not be necessary.

TABLE SHOWING ELEMENTS OF SEVERAL HIGH-VOLTAGE, LONG-DISTANCE TRANSMISSION LINES.

| Power Co. and Year Designed. | Location. | Length of Transmission. | Voltage. | Kilowatts Transmitted. | Phase and No. of Circuits. | Conductor. | Spacing of Conductors. | Height of Standard Tower and Span. | Width of Tower at Right Angle to Line. | Distance Nearest Tower Member to Line. | Type and Number of Insulators. | Highest and Lowest Wires from Ground. | Weight of Complete Tower. | Costing of Metal in Tower. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Great Western Power Company. 1907 | Northern Central California | 160 miles Big Bend to Oakland | 100,000 | 40,000 with first development | Three-phase Two circuits | No. 000 copper strand cable, 6 wires and hemp core to a strand | 10 ft. vertically | 76 ft. in height 750-ft. span | 17 ft. | 6½ ft. | 4-50,000 vt. suspended. Lock type for each conductor | 66 ft. 46 ft. | 3,800 lbs. | Galvanized |
| Stanislaus Electric Power Co. 1907 | Central California | 92 miles to Mission San Jose. 140 miles to San Francisco | 100,000 | 5,500 at present. To be increased shortly to 10,000 | Three-phase One circuit | No. 00-6 strand copper cable with hemp center | 8 ft. | 65 ft. in height 800-ft. span | 15 ft. | 3 ft. | Suspended type—Lock and G. E. | 58 ft. 35 ft. | 3,400 lbs. | Galvanized |
| Edison Electric Co Kern River No. 1. 1906 | Southern California | 117 miles | 60,000 now. Intend to raise to 80,000 | 30,000, including 50% overload at peak | Three-phase Three circuits | No. 0000 hard-drawn copper, 7-strand. Elastic limit 35,000 lbs. Ult. strength 62,400 lbs. 2,500,000 lbs. of cable used in the line | 6 ft. between wires | 30 ft. to 60 ft. 1,140 towers in 117 miles av. span is $\frac{1175 \times 280}{1140} = 542$ ft. | 12 ft. | 3 ft. | Pin type, C I. pin, 3 petticoats, 9 to the tower | 61 ft. 55 ft. | 4,250 lbs. average | Galvanized portions below ground asphalted |
| Necaxa Light and Power Co. 1906 | Mexico | 169 miles | 60,000 | 37,500 at peak | Three-phase Four circuits Two tower line | No. 000-⅛ in. diam hemp center copper strand cable, 40,000 lbs. Elastic limit 60,000 lbs. Ultimate strength 168,000 circular mils section | Circuits carried on 6-ft. triangles | 58 ft. in height Span not given | 14 ft. | 2 ft. | Pin type, porcelain petticoats, 14 in. diameter 120,000 vt. test | 46 ft 40 ft. | ..... | Galvanized |
| Winnipeg Power Co. | Canada | 65 miles | 60,000 | ..... | Three-phase Two circuits | No. 00 hemp core cable, No. 7 wires | 6 ft. | Span 400-500 ft. | .... | ..... | Pin type | 60 ft. 40 ft. | 2,240 lbs. | ..... |

The table[2] herewith is interesting, because it gives data of some very large power transmissions. The longest transmission—169 miles—is in Mexico, and no less than 37,500 horsepower passes over it.

Two transmissions in the table work at 100,000 volts, and the tendency is all in that direction, the wires being carried by suspended insulators instead of the upright pin type. Practically all long-distance transmissions have two or more

[1] Abstracted from an article by E. Kilburn Scott in *The Electrical Engineer* (London, Eng.), September 24, 1909.

[2] Acknowledgment for this table is given by Mr. Scott to *Engineering News*.

circuits, and in some of them the circuits are run over separate rights-of-way, so as to tap more country and give greater safety in case of an accident.

Although aluminum has been used for many transmissions, all those in the table are copper, and now that the price has come down, the tendency is to use the harder metal. The wires are carried on steel towers, this being the most up-to-date construction, and, indeed, practically compulsory in hot countries, where white ants give trouble. The towers run about sixty-five feet high, with the cross-bars about eight feet apart. All the metal of the towers is galvanized.

The tendency at the present time in Canada and the United States is to put all high-tension transformers and switch-work out in the open. A paper read last April by K. C. Randall before the American Institution of Electrical Engineers details the precautions which had to be taken.

Of course, the transformers are very large, say, 1,500 kilowatts, oil-cooled, and the voltages are in the nature of 60,000 down to 6,000, and so on. The oil must be non-freezing, and in very severe weather the transformers not in use are left in the circuit to make sure the oil shall not thicken, and so reduce its insulation.

Also in summer the transformers are kept cooler by a simple fence built high enough to throw a shadow over them during the hottest hours of the day. At night the heat accumulated in the oil during the day is discharged, so that the transformer starts fair with cool oil next morning. Then there are the terminals where the high-tension wires enter the transformer. These are built with layers of tinfoil in the insulation on the lines of a graded high-tension cable, so as to reduce the electric stress. The wires run down vertically into the top of the transformers, and each layer of tinfoil is provided with a water shed; but for particulars of these the reader is referred to another paper read at the same time before the American Institute by A. B. Reynders.

In January of this year about eleven miles of the transmission line of the Great Western Power Company, near Sacramento, were blown down. As the wires were carried on the latest approved manner on steel towers, seventy feet high, spaced 750 feet apart, the failure of this line was serious, especially as the old wooden pole lines weathered the storm.

Two firms of consulting engineers practicing in San Francisco were called in, and their reports, which have recently been published, are interesting reading.

The failure of the towers was due to the foundations under the legs giving way. It appears that when the ninety-two towers which failed were erected, the ground was very hard, due to a dry summer, and most of the holes were opened out by blasting the clay. When the towers were up, this hard, lumpy stuff was hastily shoveled back, and no attempt made properly to compact it. In January there were heavy floods over the country, and the water getting into these holes softened the loose refilled material and destroyed its vertical supporting power as well as its holding-down power. The result was that a heavy windstorm going up to forty-eight miles an hour found out the weak spot and overturned ninety-two of the towers.

Fortunately, comparatively little interruption to the power was caused, because one of the largest customers was the Gas and Electric Corporation, and the tap to its line was merely changed from Oakland to a point—Oroville—between the breakdown and the power house.

The investigation into the foundations was made by Messrs. Duryea, Hachl and Gilman, and their recommendations will no doubt prevent any such accident ever happening again, and fortunately so. A few like that, and long-distance power-transmission practice would receive a severe setback.

One result of the failure of the above transmission was that an investigation was also made by Galloway & Markwart into the design of the steel tower. Two towers which had been firmly anchored down were tested to destruction by pulling on the three cross-arms horizontally and at right angles to the direction of the transmission. The first tower failed with 8,400 pounds, and the second, which had been strengthened, gave way with 11,250 pounds. The experts then assumed wind velocity of seventy-seven miles per hour, which is equal to thirty pounds per square foot, and from the area presented to the wind they worked out the total pressure as follows:

| | |
|---|---|
| One steel cable..... | 527 pounds |
| Six copper cables..... | 4,218 pounds |
| Force on tower..... | 2,100 pounds |
| Total ..... | 6,845 pounds |

This force is not exactly comparable with the test force applied, because in the test there was lacking the weight of the transmission cables which produces a moment that counteracts the moment of the wind. It was estimated that 345 pounds applied at the top of the tower would be equal to this, so that the total wind would be 6,500 pounds.

Therefore, the factor of safety works out at 8,400/6,500 = 1.3 to 1 in first test, and 11,250/6,500 = 1.73 to 1 in second test.

The factors are too small when one considers the immense importance of keeping power on the line. A failure means loss of prestige and standing with power consumers, besides the money loss. In bridges it is common to allow four or five, and in buildings four to one.

It is to be hoped that in future American contractors will be thorough in their work, and the designers more liberal in their factors of safety.

### Waterhammer and Steam Explosions.

An interesting pamphlet dealing with waterhammer in steam pipes has been issued by C. F. Stromeyer, chief engineer of the Manchester (Eng.) Steam Users' Association, says *Nature,* of London, Eng.

According to the (British) Board of Trade reports, waterhammer has been the cause of about 120 steam-pipe explosions. Mr. Stromeyer finds that nearly one-half of these have been due to the absence of drain-cocks on steam pipes, or to their injudicious use. A large number, chiefly on steamers, have been produced by admitting steam into pipes containing water. Others have occurred when water was admitted into steam pipes, or when steam condensed in them. Steam being admitted through valves on which water was resting, injudicious opening of valves having steam and water on both sides, and injudicious manipulations of steam valves, whereby plugs of water have been set in motion, have all contributed to swell the total of explosions.

Mr. Stromeyer considers it inadvisable to lay down at present definite rules for the design of pipe arrangements in general, having been led to this conclusion by the fact that draining arrangements, designed to obviate explosions, have caused the majority of accidents, and also because in many cases of complicated pipe arrangements the waterhammer may often be attributed to any of the above-mentioned causes. Mr. Stromeyer complains of the insufficiency of the official reports of explosions having given him much difficulty in arriving at definite conclusions.

### A New Australian Central Station.

An interesting example of Australian central-station practive is afforded by the Balmain (N. S. W.) works of the Electric Light and Power Supply Corporation, which were recently opened by the mayor of that town.

The plant, which is situated on an excellent site possessing a water frontage of 270 feet, is contained in a fine steel-framed building, and comprises two 5,000-volt, three-phase Thomson-Houston generators, direct-coupled to two Bellis & Morcom triple-expansion engines of 1,200 horsepower. The boiler plant includes two Babcock and Wilcox water-tube boilers fitted with superheaters and automatic chain-grate stokers, and a third Babcock & Wilcox boiler connected with a garbage destructor, the latter being more than sufficient to supply the steam necessary for lighting the whole of Balmain. The supply is controlled by a switchboard supplied by the Australian General Electric Company. The plant specifications were prepared by J. E. Donoghue, who is the chief engineer and general manager of the Electric Light and Power Supply Corporation.

### Measuring Holes by Electricity.

A novel use for electricity is recorded in a recent issue of the *Scientific American,* as follows:

One of the employes of a Chicago firm dealing in perforated metal to be used in flour mills has devised a simple measuring device for readily matching samples brought in by customers. A tapering needle, which is pushed into one of the perforations as far as it will go, carries a brush that passes a series of electric contact pieces. The latter are connected to a set of solenoids, and when the circuit is closed by pressing a button, one of these solenoids operates to uncover a number indicating the correct size of the hole.

### A Prussian Searchlight Rifle.

Vice-Consul-General Charles A. Risdorf, of Frankfort, states that a German publication, *Army and Politics,* has caused a sensation in military circles by describing a new appliance for a gun to enable a soldier to take aim at great distances in complete darkness. The inventor is an engineer of Dortmund, named Issel. A telescopic searchlight containing a small electric lamp is fixed to the barrel below the stock. Military authorities are said to have made successful trials, and all shots took effect.

### Waterpower in Iceland.

Iceland is comparatively rich in waterpower which still awaits its exploitation, says *Engineering* (London, Eng.), but a move in this direction is now being made by a limited company formed for that purpose.

The Skjälfandi River Falls are divided into three groups—the Aldeyjar Falls, with an aggregate head of 190 feet; the Goda Falls, with a divided course and respective heads of about ninety feet and eighty-three feet. The aggregate power of the Goda Falls is calculated at 39,200 horsepower, and that of the Aldeyjar Falls at 45,800 horsepower. The Barna Fall, north of the former fall, has a head of fifty-five feet, and an estimated capacity of 17,000 horsepower. The Laxau River Falls can easily be regulated so as to yield between 25,000 and 30,000 horsepower.

In the southern part of the island are the Sog Falls, three in number, which, with minimum water level, can yield 50,000 horsepower, which, however, can by regulation be increased to some 60,000 to 70,000 horsepower. The Guldfoss Fall is in the Hoitaa River before it joins the River Sog. This important fall is calculated to yield some 100,000 horsepower, which, by regulation of the river, can probably be increased to 150,000 horsepower.

It will thus be seen that a considerable amount of waterpower is available in Iceland, particularly adapted for electrochemical installations.

### Large Aluminum Contract.

The Hydroelectric Power Commission of Ontario, Can., has recently placed a contract with the Aluminum Company, of America, for 1,500,000 pounds of half-inch aluminum wire, to be delivered as quickly as possible. It is the intention of the commission to transmit power from Niagara Falls through the province of Ontario at the lowest possible rates, thus inducing large plants to locate there.

### An International Congress of Radiology and Electricity.

Arrangements have been made for an International Congress of Radiology and Electricity to take place at Brussels in connection with the exhibition to be held there in 1910, says *The Lancet* (London, Eng.). The Congress, which will meet on September 6, 7 and 8, will be held in three sections. In the first section, general questions of terminology and methods of measurement in radio-activity and subjects connected with ions, electrons and corpuscles will be dealt with. The second section will be divided into various sub-sections, dealing respectively with fundamental theories of electricity, the study of radiations (including spectroscopy, chemical effects of radiations, and other allied questions), radio-activity, atomic theory, cosmical phenomena (including atmospheric electricity and atmospheric radio-activity). The third section will be biological and will be devoted to consideration of the effects of radiations on living organisms. The section will deal with purely biological questions as well as with the use of various radiations for medical purposes, both for diagnosis and therapeutics. In order to insure the success of the Congress, committees have been formed in the various countries which will take part in the Congress, and the following scientists have already consented to act as presidents of the committee in each country: Professor Lenard (Germany), Professor Exner (Austria), Professor Oëtvös (Hungary), Professor Castillo (Spain), Professor Barus (United States), Professor Langevin (France), Professor Rutherford (Great Britain), Professor Blaserna (Italy), Professor Birkeland (Norway), Professor Lorentz (Holland), Professor Ferreira da Silva (Portugal), Professor Hurmuzescu (Roumania), Professor Lebedew (Russia), Professor Arrhenius (Sweden), and Professor Guye (Switzerland). Anyone wishing to become a member of the Congress should communicate his intention directly to the general secretary, Dr. J. Daniel, 1 Rue de la Prévôte, Brussels.

### London Railways to Replace a Four-Year-Old Turbine Equipment.

The London Underground Railways, which were electrified in 1905, have decided to replace their present double-flow impulse and reaction turbines by Parsons turbines. By this change it is expected to reduce the fuel cost by $150,000 a year. The new turbines will use about 13.4 pounds of steam per kilowatt-hour of current produced, as against about 20.0 pounds required by the old machines.

There has been some talk of a possible further change, in the course of the next few years, to gas engines and producer plants, as some experts consider these would effect a still further economy in coal consumption. In fact, one writer in a recent London trade paper predicts that this may happen even before the new turbines shall have fulfilled their allowance for depreciation.

# TELEGRAPHY—TELEPHONY, and WIRELESS.

## Automanual Telephone Exchange at Ashtabula Harbor, Ohio.

In Ashtabula Harbor, Ohio, there has recently been installed the first commercial telephone-exchange equipment of the Clement automanual type. The Ashtabula Harbor board has now been in operation six months, under conditions as severe as any to be met in telephone practice. Daily tests have been made and careful records kept, and based upon these it has been shown that all previous estimates have not only been confirmed but exceeded in the showing actually made.

The city of Ashtabula has a population of about 20,000, and is divided into the main town, situated about four miles from the lake, and the Harbor, situated at the mouth of the Ashtabula River on the lake. The local population of the Harbor is only 5,000, but conditions there are peculiar, partly due to the fact that it is a very busy port; indeed, it is said to be the largest ore port in the world. It goes without saying that it has extensive railroad terminals, which handle practically all the ore for the Pittsburg district.

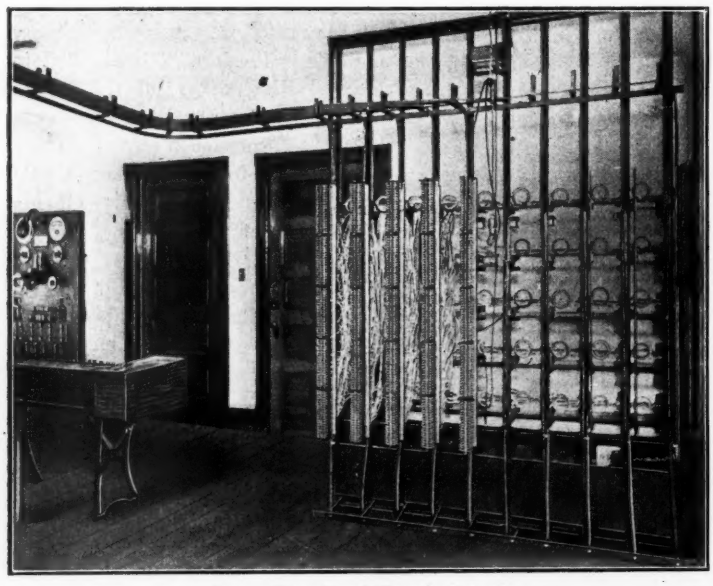
Prior to the present installation, telephone service has been given by two manual switchboards, that at the main exchange in the town being of the common-battery multiple type, with 1,200 lines installed, and that at the Harbor a magneto transfer board with approximately 350 lines. The two boards were connected by open wire leads, there being ten trunks each way. These were destroyed in the sleetstorm of March, 1909, and were replaced just prior to the present installation by aerial cable.

The service at the Harbor required seven operators for a night and day shift, while the main exchange employed thirty to accomplish the same service. The number of subscribers served at the Harbor exchange prior to the cut over to automanual service was 424, and the number at the main exchange was 1,916.

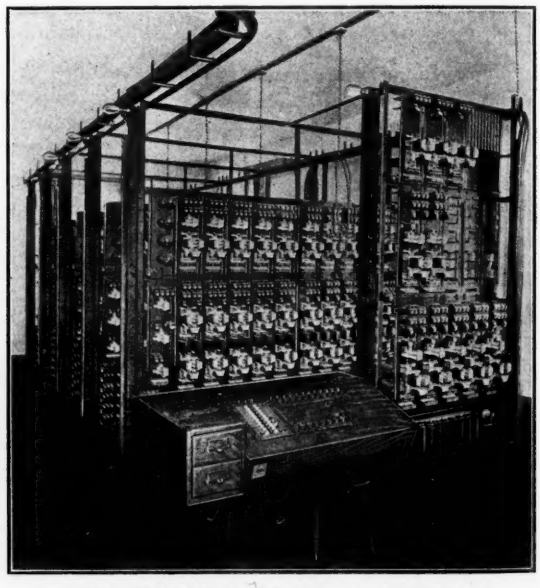
It was considered that the conditions thus stated were quite favorable for a thorough demonstration of the possibilities of the automanual equipment, and the builders of the original boards contracted to re-equip both the main and Harbor exchanges, with the idea of starting first at the Harbor with local operators, and after that exchange was successfully working, equipping the main exchange so as to centralize all the operators therein, leaving the Harbor practically an automatic branch. By following this plan, additional economies will be effected, in that the day load at the Harbor will only call for one additional operator at the main exchange, and the night load will be handled by a single operator at main. A brief statement of the general scheme will make this clear.

The fundamental idea underlying the automanual system is that of providing skilled and efficient service, and the carrying out of this idea results in the practical elimination of all cords, plugs, ringing and listening keys, line lamps, answering and multiple jacks, together with their complicated attendant wiring; the retention at the subscriber's station of the simplest present known form of equipment, namely, a standard common-battery telephone; the elimination of "B" operators entirely; the simplification of the "A" operator's duties to a point whereby efficiency of operation is vastly increased and the service correspondingly improved.

Apart from the means by which the operators are used to the greatest advan-



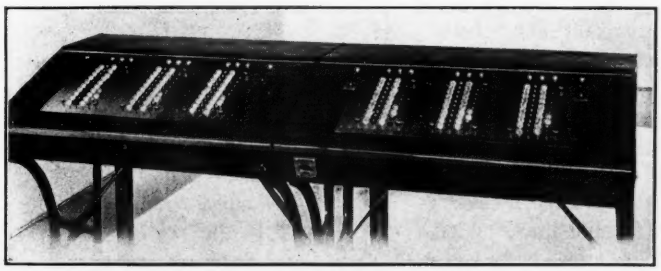
Power Board and Terminal Rack.



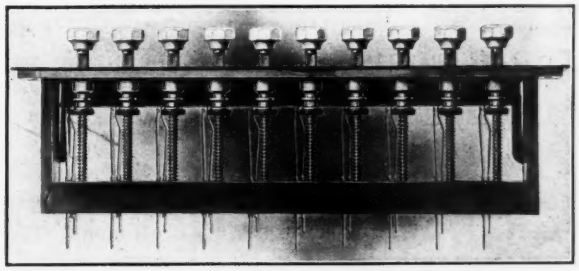
Wire Chief's Desk and Automanual Switches.

AUTOMANUAL TELEPHONE EXCHANGE AT ASHTABULA HARBOR, OHIO.

tage, a striking economy is rendered possible by the employment of mechanical switching means, in that an exchange system can be subdivided practically without limit into centers and subcenters, served by distributed automatic equipments working on the principle of branch exchanges, all controlled from one main operating point or clearing house. The extent of saving thus effected may be realized when it is recalled that over ninety per cent of the cable and wire plant in local-exchange territory is idle all of the time; and by complete subdivision this percentage can be reduced to twenty-five per cent, or even less, according to traffic conditions in the territory. In other words, instead of having a single large multiple board serving a large number of lines divided arbitrarily among fixed positions, groups of short lines are carried from the subscribers' stations to local automatic centers, interconnected by talking trunks only sufficient in number to take care of the maximum load between these centers,



FRONT VIEW OF TWO-OPERATORS' POSITION BOARD.



STRIP OF KEYS FROM OPERATOR'S KEYBOARD.

all of these branch automatic equipments being controlled by a single centralized group of operators among whom the total load on all the centers can be uniformly distributed at all times, so that fluctuations in any one center or group of subscribers are distributed, and only the total load need be provided for at any given time. All the operators work at maximum efficiency all of the time, while the cable and wire plant is theoretically at almost one hundred per cent efficiency during the busy hour, as against ten or fifteen per cent in the manual systems.

At the Ashtabula Harbor exchange are installed five units of one hundred lines each, each line adapted for either single or party-line service, thus insuring both flexibility and load capacity without the loss of any group or groups of numbers.

Each unit is complete in itself, requiring the use of no outside apparatus for the completion of a call, having the line and cut-off relays mounted upon angle plates at the bottom, with the necessary trunk switches and relays above. These units are assembled, wired and tested out in the factory, and the only installation required upon the ground is the connecting of the line and trunk cables, together with the battery-supply and ringing-current wires.

The operator's equipment is extremely simple and somewhat resembles the ordinary school desk. Two positions are provided, and each position is equipped with three sets of numbered keys, almost identical in appearance and method of manipulation with those of the ordinary adding machine.

Each set of keys has its own lamp signals, a listening button and a starting button. Each complete key set consists of three vertical rows of numbered buttons, and an additional row of four buttons for selective ringing. Connected to those key sets is a power-driven impulse sending machine, from which groups of impulses are taken corresponding to the numbers of the keys depressed. From each key set an operator's trunk is taken to what is called a secondary selector switch, through which it may be connected to a primary collector trunk and calling line.

The subscriber's metallic line circuits come in to the exchange building, and after passing through the usual main frame terminals and protectors, are ended upon the usual line and cut-off relays, and the local trunks or link circuits between the primary selector and first selector switches are provided with condensers, and sleeve and tip relays on the main battery, so that the circuit conditions are identical with those in standard common-battery manual boards.

The operation of this equipment is as follows: When a subscriber calls by taking down his receiver, his line relay pulls up and causes a primary selector switch to connect his line with an idle trunk or link circuit, at the same time starting up a secondary selector switch, which immediately connects the primary trunk and the calling line to an operator's idle key set. The key-set lamp then lights, thus indicating the call, the operator comes in on her listening key as usual, gets the number, and depresses the corresponding buttons, thereby determining the number of impulses to be sent to the selector and connector switches to make the desired connection. The operator then repeats this number to the calling subscriber and presses the starting button. The sending machine transmits the predetermined impulses to the switches, which then select, test, and ring the wanted line automatically. As soon as this line is selected, however, the secondary selector or operator's switch is automatically released and restored to normal position, ready for another call.

The subscribers have entire control of their own connection, being in this respect situated precisely as in a full automatic exchange, and it will be observed that they are secure from interruption, because it is impossible for any of the operators to cut in or secure access to a line or trunk after a connection is established. To clear-out or make a re-call the subscribers simply hang up their receivers, when switches are automatically restored.

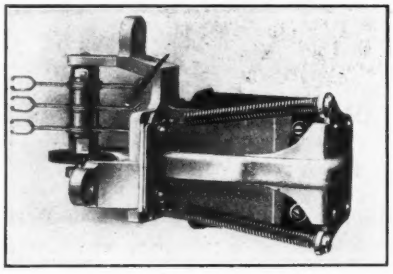
The location of the operating room adjacent to the switches is a matter of choice and not of necessity, because the only wires having direct access to the operators' keys are their own secondary trunk wires which can be made of any length desired. Thus it is possible to carry these trunks from a common point to more than one switching center, so that the operators can be centralized.

Since the operators' trunks are only in use for each call, during the brief time necessary to answer and send the impulses required to make connection, they are at maximum efficiency all the time, and the number required is relatively very small, figuring in large exchanges at less than one per cent. Subscribers' connecting trunks do not necessarily pass to the operating center, but directly between the various switching centers, and are laid out solely with an eye to traffic requirements

between the centers and the groups of subscribers which they serve. Should the operators, for convenience, be located at a switching center, then their secondary trunks would be distributed along with the main connecting trunks, and may be in the same cable. As they constitute in effect automatic order wires, they can be handled in the ordinary way as stated.

From the foregoing it is clear that when the main exchange in the town of Ashtabula is fully equipped, the present operators' positions at the Harbor can be put out of commission, all calls from the Harbor subscribers going to the operators at the main exchange through their secondary trunks or order wires, and the selective impulses coming back to the Harbor switches by the same route. In any branch as important as this, however, it would be unwise to dispense entirely with local operating means, hence this will probably be kept at the Harbor indefinitely for use in case of emergency, such as would arise, for example, through accident to the trunk cable, or a fire in the main exchange.

There are no rural lines terminating at the Harbor, and no toll lines, as all



AUTOMANUAL DISTRIBUTING SWITCH.

service of this character is handled from the main exchange. When the cut-over is made at the main exchange, the rural lines will be handled in the same manner as local lines, with the added feature of furnishing ten-party selective service through the use of five frequencies, and ringing to ground through condensers on both sides of the line. Toll business will be handled as at present through a local toll board.

The power plant consists of a duplicate set of storage batteries of 120 ampere-hours capacity each, and each set consists of twenty cells, thus the system is a forty-volt system. A direct-current charging set and power switchboard completes this outfit.

Ringing is accomplished through the medium of a duplicate set of synchro-harmonic converters supplying current at the frequencies of thirty, forty-two, fifty-four and sixty-six cycles, and four-party selective service is furnished.

Aside from the standard equipment incident to all common-battery installations, such as power plant, protecting and ringing devices, there are but five different pieces of apparatus required to complete this automanual installation. These are: The impulse or sending machine, the operator's keys, the automanual relay, the 100-point two-motion switch, the twenty-point, one-motion switch.

An examination of the sending machine reveals a simple but well made device consisting of a drum upon which are placed cams arranged to furnish impulses from one to ten in accordance with the keys depressed by the operator. It is driven by a small motor direct from the storage batteries. This sending machine is common to the entire system and performs for the system the same functions that in a full automatic installation are performed by the dial or sending device, located at each subscriber's telephone. Its use means the elimination of the dial investment and its attendant maintenance cost. No sending machines are required at branch exchanges, but only at the point where operators are located.

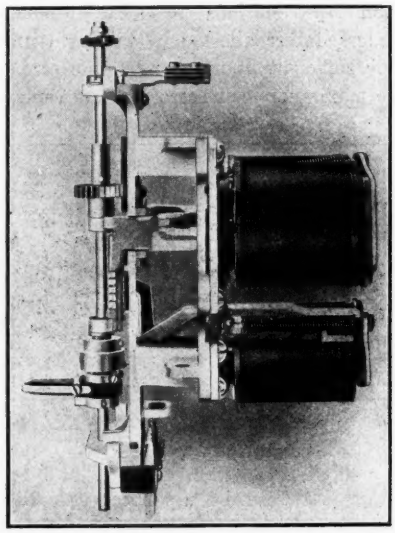
The racks are of open steel construction and each rack carries the line and cut-off relays, together with the necessary trunking apparatus for 100 lines. What may at first appear as unnecessary complication in this, upon analysis resolves itself only to such necessary duplication of but three pieces of apparatus as the number of lines served require. These three pieces of apparatus consist of a 100-point two-motion switch, a twenty-point one-motion switch, and a relay.

The relay consists of a core upon which the wire is wound, a frame, an armature and a spring block which serves the double purpose of carrying the contact springs and retaining the armature in place, at the same time allowing freedom of movement. The armature extension which causes the movement of the springs is in the same direction as the springs themselves, thus permitting the spring movement to be accomplished with but a very little over one one-hundredth of an inch air gap. This construction results in an exceptionally powerful and sensitive relay.

In the 100-point switch the same principles regarding air gaps have been applied that were used in designing the relay. The three switch movements, rotary, vertical, and release, are identical in construction, and interchangeable. The armatures are mounted upon hardened knife-edge bearings extending across the entire length of the armature and held in place by spiral return springs, which then perform a double duty. All adjustments are effected by means of steel blades recessed into the die-molded frames at an angle of fifteen degrees from the opening through the blade, which limits the motion sought to be controlled. This method of adjustment is positive and cannot be shaken loose in service, hence a switch once adjusted is adjusted for all time. The bank contacts are placed vertically to prevent dust accumulation, and thus the rotary motion precedes the vertical.

The one-motion twenty-point switch is very similar in construction to the 100-point switch.

All circuits are balanced, and contain no greater number of talking contacts than



AUTOMANUAL 100-POINT SWITCH.

a standard common-battery cord circuit. There is not a relay in the system having more than one winding or more than one armature, nor a set of spring contacts in which it is necessary to establish one contact before breaking another. Controlling impulses are not required to pass over the varying length of subscribers' lines, but are local to the exchange itself, hence all switch adjustments are alike and all switches once adjusted remain adjusted, as the conditions under which they are called upon to operate are constant and not fluctuating.

Variations in battery voltage have absolutely no effect upon the system, as the apparatus will work with equal facility whether taking current from cells freshly charged or exhausted to as low a point as storage batteries can be carried without injury to themselves. No grounds are used except upon rural lines of more than

five parties. The action of each piece of mechanism is positive and its function direct.

The operator of the Clement automanual system is not hampered with a multiplicity of interlacing cords and plugs when a load comes on; for it is not necessary to watch for the lamp of a calling subscriber among a distributed group, neither is it necessary to give attention to the waiting call first to secure an idle cord and insert its plug into the answering jack, at the same time throwing into and holding in position the listening key, all of which the manual operator must do before the wants of the subscriber can be ascertained. Many other details must be attended to with manual systems.

On the other hand there is nothing in front of the automanual operator but three simple sets of keys, placed at a convenient angle upon the top of the desk. No reaching in any direction more than ten inches is necessary, and only three sets of lamps must be watched, and these lamps cannot flash.

A call comes in, lighting the lamp upon one key set. The listening key must be pressed, but not held, for the first touch has brought up a relay which locks the operator's head set upon the calling line. On ascertaining the number wanted, the operator sets it up on the keys and touches the starting key, which releases the relay which was brought up by the operation of touching the listening key, thus starting the call through the automatic switches, where it is completed. No matter where the call comes from or where it is going to, the procedure is the same.

There is no possible way for an automanual operator to get in on a call when once the starting key has been pressed, and it is utterly impossible for two sets of subscribers to land upon the same trunk or talking circuit, hence all conversations between subscribers are absolutely private. Where the load requires a number of operators the result is the same, for the incoming call will take the first idle key set in the entire group of operators.

An automatic register, consisting of a Veeder counter operated by a relay, is permanently connected to each key set, hence the management has knowledge of the exact number of calls handled by each operator at all times. The mechanism is impartial and gives every operator exactly the same opportunity. The registers accurately disclose the comparative efficiency of each operator.

Any girl of average intelligence can be converted into an operator in an hour's time, and a few days' practice will bring her efficiency up to the standard. Interesting and successful experiments have been made with blind operators, the only change necessary being to give them an audible signal instead of a lamp.

Each unit frame carrying the automanual apparatus for 100 lines is entirely self-contained and its dimensions are as follows: Six feet three inches long; seven feet four inches high, and eight-and-one-half inches in thickness; weight, 600 pounds, or six pounds per line. The units are placed upon three-feet centers. In cases of limited floor space this could with safety be slightly reduced, and in no event would there ever be any occasion for increasing it.

A vertically mounted terminal rack is carried upon each end of the frame, one for the purpose of connecting the cable to the main distributing board, and the other to unite the interconnecting trunks between units. These units are wired up complete, switches and relays mounted thereon and tested out before shipment from the factory. When packed for shipment each frame, together with its enclosing case, will pass through any standard door and can be placed in permanent position before removing the case, which eliminates any chance for injury in either shipping and handling.

The only work of installation remaining is to solder in the cables above referred to, and the unit or units are ready for operation, provided, of course, that power plant and main distributing board, ringing device, etc., are in place. The equipment for the operating room is so simple and the connecting wires so few that the operator's equipment for a 5,000-line installation can easily be installed in one day by two men.

The Clement automanual telephone exchange at Ashtabula Harbor was made and installed by the North Electric Company, of Cleveland, Ohio.

### Neon and Electric Waves.

In a recent letter to the editor of *Science,* W. L. Dudley, of the Vanderbilt University, writes as follows:

"Prof. J. Norman Collie, F. R. S., recently discovered that when perfectly pure neon is enclosed in a glass tube with a globule of mercury and shaken, it glows with a bright orange-red color, and when the globule rolls it appears to be followed by a flame. This phenomenon takes place at ordinary pressure.

"Sir William Ramsay has found that neon is the best conducting of the gases and that it readily becomes luminous under the influence of electric waves. Professor J. A. Fleming, F. R. S., uses a neon tube as a detector for the wavelength of Hertzian waves in his apparatus for measuring them.

"During a recent visit to Sir William Ramsay I had the pleasure of seeing the astonishing quantity of over 500 cubic centimetres of pure neon which he had obtained from about 120 tons of air. While there, Professor Collie very kindly presented to me a tube of neon, under about one-half an atmosphere pressure, containing a globule of mercury which showed the 'Collie effect' very strikingly.

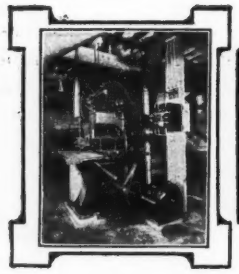
"Returning from Liverpool, July 2, on the steamer *Baltic,* I was given opportunity during the voyage, by Mr. Bates, chief operator of the wireless, to try the neon tube as an instrument for the visual reading of the wireless message. We experimented with it during two nights and found that the neon glowed beautifully in response to the waves sent out, but the waves as received were too weak to visibly affect the neon, although we tried every arrangement of the limited apparatus at our command. The electric wave sent out by the Baltic's apparatus was, according to Mr. Bates, about 800 feet long."

### New Ruling on Telephone Installation.

The Nebraska State Railway Commission, in a recent ruling, held that although one of two telephones might give adequate service, in the office of an express company, it could be compelled to install the other.

Chairman Clark stated that, while under the common law, one telephone might be sufficient in the case of the Norfolk Express Company, the ruling must be made, under the Bartos act, which authorizes the railway commission to require the installation of telephones in express and railway offices.

An agreement has been reached between the Panama Government and the United Fruit Company, whereby the latter will establish wireless stations at Colon and Bocas del Toro similar to the one the company maintains at Limon, Costa Rica. Through its new land telegraph facilities, and the proposed wireless system, the Panama Government will be able eventually to route messages from Panama to Bocas del Toro, Limon and other points. Under the agreement with the fruit company, the Panama Government is permitted to fix its own rates for messages.



# Industrial Power

### Speed Control of Electric Motors.

Many people, says Michael Longridge, in his annual report to the British Engine, Boiler and Electrical Insurance Company, seem to think that if a controller containing resistances in series with the armature of a motor will give certain variations of speed at full load, the same controller will give the same variations at light load. A few words on the subject of speed control may be serviceable.

In 1908 the company was asked to inspect some electrical plant for a colliery proprietor, and, among other things, an eighty-five horsepower, compound-wound motor and controller for underground haulage. The motor was to receive current at 450 volts, and was to run with the controller resistance cut out, at speeds varying from 420 revolutions per minute at full load to 450 revolutions at no load. The controller was specified to have six contact studs and resistances capable of reducing the speed from 420 to 210 revolutions per minute at full-load torque, and to carry the full-load current for fifteen minutes with the regulating switch on any contact. Both passed their tests satisfactorily at the makers' works, were certified by the company, sent to the colliery, and erected there, but no sooner was the current switched on than the owner began to complain that the controller was irregular in its action, and at light loads would hardly reduce the speed at all, even when all the resistance was in circuit. In the course of the correspondence which ensued it appeared that he wanted, and had expected to get, a controller not only fulfilling the conditions described at the beginning of this paragraph, but capable of giving any speed, between eighty revolutions per minute and full speed, at any load. The company explained that the controller specified could not possibly give the variations of speed he asked for, even if the resistance were very much increased, and the following table was calculated and sent to him, to show what speed reductions could be made at various percentages of full load, with about eight times the resistance originally supplied. It was at the same time explained that unless a new controller having a greater number of contacts were provided it would not be possible to approach any nearer to his requirements. He eventually decided to have the resistances increased, and to be satisfied with the speed control shown by the table.

This table shows that, although the controller with the increased resistance was able to reduce the speed from 420 revolutions per minute to fifty revolutions per minute when taking the current required to give the full-load torque, it did not effect the same reductions with smaller currents.

For instance, at fifty-eight per cent of the full-load torque, the lowest speed was 210 revolutions per minute. If the switch were moved on to the second contact to reduce the speed still further, the motor would stop altogether, unless at the same time the torque were reduced to 51.6 per cent of the full-load torque, when a speed of ten revolutions would be obtainable. Similarly it shows that with a current of forty amperes, sufficient to give 25.8 per cent of the full-load torque, the lowest possible speed was 230 revolutions per minute, but on reducing the current to thirty amperes the eighty revolutions asked for would be possible.

The effect of the load upon the speeds obtainable with given resistances is explained by Ohm's law. The speed of a shunt-wound motor, except for the effect of armature reaction, which may be neglected, depends exclusively upon the volts across the armature, while the current is determined solely by the torque required to overcome the drag of the load. Thus, so long as the torque remains constant, the volts across the armature, and consequently the speed, vary only with the resistance in the circuit, and therefore can be regulated at will by putting suitable resistances into the circuit. But as soon as the torque, and consequently the current passing, changes, Ohm's law shows that the voltage with any given resistance changes also, and that the series of speeds which were obtained by the series of resistances determined for a certain torque and current will no longer be obtained if the torque and current vary, but will be higher or lower than the required speeds as the torque is greater or less than the torque for which the resistances were calculated. Ohm's law also explains why the effect of moving the controller arm back one contact in certain cases shown by the table is to stop the motor instead of reducing its speed, for in such cases the supply voltage divided by the increased resistance is equal to a current which is less than that which will give the torque required to turn the load.

TABLE.

| Per cent of full load torque | 6.45 | 12.9 | 19.3 | 25.8 | 32.3 | 38.7 | 45.2 | 51.6 | 58 | 64.5 | 71 | 77.4 | 84 | 90 | 96.7 | 100 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Amperes... | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 | 140 | 150 | 155 |
| Position of Controller. Contact. | Revolutions per Minute | | | | | | | | | | | | | | | |
| 1st ..... | 333 | 208 | 80 | 0 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| 2d ..... | 403 | 346 | 290 | 230 | 175 | 115 | 60 | 10 | 0 | .. | .. | .. | .. | .. | .. | .. |
| 3d ..... | 433 | 407 | 380 | 354 | 328 | 300 | 270 | 240 | 210 | 190 | 170 | 142 | 115 | 90 | 60 | 50 |
| 4th ..... | 443 | 427 | 410 | 454 | 377 | 360 | 345 | 328 | 312 | 295 | 280 | 262 | 245 | 230 | 215 | 205 |
| 5th ..... | 450 | 444 | 435 | 428 | 420 | 412 | 404 | 396 | 388 | 380 | 372 | 364 | 356 | 350 | 340 | 335 |
| 6th ..... | 450 | 448 | 446 | 444 | 442 | 440 | 438 | 436 | 434 | 432 | 430 | 428 | 426 | 424 | 422 | 420 |

The speed of a compound-wound motor is further modified by the effect of the series windings. This effect in the case here referred to is shown by the figures in the last line of the table, which gives the speed with the controller switch on the sixth contact and all the resistance cut out.

Of course, the difficulty of speed regulation by resistance in series with the armature could be overcome by increasing the number of contacts, but this would mean a considerable increase in cost of the controller. The ideal controller from this point of view is no doubt one with a liquid resistance, for it will give an even graduation of speed, but the prac-

tical difficulties as regards dimensions, generation of gas, etc., in many cases counterbalance its advantages.

It may also be mentioned that all forms of speed control by resistance in series with the armature are wasteful. If the speed of a motor be reduced to half its full speed in this way, the power absorbed is the same as if it were running at full speed, but the power given out is only one-half; the other half is wasted in heating the resistance coils. Control by resistance in the shunt circuit has, on the other hand, a high efficiency, and can be used with modern motors with interpoles for a speed variation of one to six. But this efficiency is only obtainable at a high first cost. For as the effect of putting resistance in series with the shunt is to increase the speed by weakening the field, the motor must be large enough to give the torque required to overcome the resistance of the full load with the weakest field. Thus, a motor with speed control by resistance in series with the shunt, capable of giving eighty-five horsepower at 420 revolutions per minute with all the controlling resistance in, and the same torque at eighty revolutions per minute with all the resistance out, would have to be large enough to give 450 horsepower at 420 revolutions per minute with no resistance in series with the shunt. In other words, to get the efficiency due to shunt-sped control a 450-horsepower motor must be put down instead of an eighty-five-horsepower motor.

There are, of course, other combinations by which wide variations of speed can be obtained, combinations of series and shunt resistances in conjunction with a single armature or with two armatures workable in series or in parallel, but none of these is of universal application. Each case must be considered on its merits, having regard to first cost, working cost, and graduation of speeds required.—*From the Mechanical Engineer (Manchester, England), September 10.*

## Cincinnati Proposes to Build Municipal Subway.

Plans for the construction of a subway to connect the business part with the outlying districts of Cincinnati are now before the City Council. The plans are said to have the indorsement of the city administration. The expenditure of from $10,000,000 to $15,000,000 would be involved in the project, which contemplates municipal ownership of the subway, city and interurban terminals.

## Electric Development in Birmingham, England.

Consul Albert Halstead reports as follows concerning the increased use of electrical motive power in Birmingham since that English municipality bought out the Birmingham Electrical Supply Company in 1901:

In the year ended March 31, 1901, the total units sold for lighting and power purposes amounted to 3,040,822, while for the year ended March 31, 1909, the units aggregated 12,623,818. This does not include 11,782,409 units sold to the city tramways for traction purposes. Including these, the total for the year ended March 31, 1909, was 24,406,227 units, or eight times the amount supplied when the city undertook control. A particular point has been made of pushing the sale of electricity for motive purposes, with good results. In 1901, 750 horsepower of electric motors were connected with the city supply, and in 1909 this had grown to 14,365 horsepower.

In the year 1907 the management of the city electrical department concluded to institute a plan of renting out electric motors for motive purposes. In that year motors aggregating 992 horsepower were rented out, while in 1909 the total horsepower rented had increased to 2,549. Special attention had been paid to supplying power to large manufacturing works. A three-phase, high-tension, alternating current, at a pressure of 5,000 volts, is distributed for this purpose. Quite recently Birmingham firms engaged in the rolling-mill industry, of which there are many, chiefly engaged in rolling brass and copper or drawing brass and copper tubes, or drawing copper and silver wire, have been encouraged to rent motors and substitute electrical for steam power.

The rolling mills that have substituted electrical for steam power are reported to have found the results most satisfactory. Among the advantages obtained has been a great saving of space, that which hitherto was required for engines and boilers being now utilized for factory purposes, while in one case a pit has been built in which the motor is placed, so that the whole building can be used for manufacturing. In two instances, with an electrical motor of the same horsepower as the previous steam engine, an increased output has followed, aggregating in one case twenty per cent and in another fifteen per cent. This increased output is due to greater economy in the use of power from the non-stalling of the machinery. The cost of power has also been found, in many cases, to be cheaper than steam. In one case a firm has found that the saving it has made by the new arrangement will enable it to pay off in five years the capital expenditure necessary to install the new motor. The steady drive and economy have also tended to prove electric power to be more suitable than steam engines.

For current the prices now in force are as follows:

For lighting, maximum charge four pence (eight cents) per unit, with a sliding scale down to two pence (four cents) per unit, five per cent discount being allowed for prompt payment.

For low-tension power and heating supply, maximum charge 1.35 pence (2.7 cents) per unit, with a sliding scale down to 1.1 pence (2.2 cents) per unit, subject to five per cent discount for prompt payment.

High-tension power supply, maximum charge one penny (two cents) per unit, with a sliding scale down to 0.7 of a penny (1.4 cents) per unit, subject to five per cent discount for prompt payment, and to a minimum guarantee of $1,217 per annum. In some cases where the cost of the supply mains is heavy an increased guaranteed sum per annum is required.

The city charges for service lines laid through private property, quotations being made before the contract is signed, and for conveying and installing motors are not high. The rental charges for the different sizes of motors run from $12 per annum for a one-half horsepower to $127 for a fifty-horsepower motor. These terms are attractive to the small power user, because an efficient and reliable motor can be obtained at a reasonable rental, which includes fair wear and tear and periodical inspection. The consumers can obtain hire-purchase terms, by which the motors become their private property at the end of three years.

The advantages of taking a motor on hire, as given by the city electrical department, are: Manufacturers can deal with a sudden increase of the volume of business without going to heavy expense in installing additional power; the existing motor may be changed for one of a larger or smaller size at any time, to meet the requirements of business; experiments can be made in the extension of a manufacturer's business without involving heavy initial expenditure, and if the venture is found to be unsatisfactory another method may be substituted without serious financial loss.

## BOOK REVIEWS.

**"Webster's New International Dictionary." Editor-in-chief, Dr. W. T. Harris. General editor, F. Sturges Allen. G. & C. Merriam Company, Springfield, Mass. In various bindings, 2,700 pages (8¾ by 12 inches); 6,000 illustrations. Supplied by the ELECTRICAL REVIEW AND WESTERN ELECTRICIAN for $12 (sheep, marble edge, indexed) or more, according to style of binding.**

This latest, biggest and best of the Webster series of dictionaries, is not a rehashed edition of the well-known "International," but an entirely new work, built on the skeleton outlines and well-proved traditions of its predecessors. The New International includes over 400,000 entries, more than double the number in the International, besides the separate geographical and biographical lists, which are inserted as appendices. A first glance reveals some novel features, chief of which are the systematic definitions and the arrangement of the type. The systematic definitions may be best described and exemplified by a particular case. For instance, the mechanical definition of the word *file,* on page 814, gives first the general meaning of term, this being followed by a differentiation from the similar term *rasp.* The different "cuts" of file are then explained, after which is the grading of files according to fineness. Classification according to cross-section follows, including terse and accurate definitions of such terms as *flat, round, square, triangular, three-square, half-round, cant, canted* (*five-canted, six-canted, etc.*), *lightning, knife, cross, crossing, double half-round, great American, pippin, auriform, lozenge, onglette, oval,* etc. The next division is into general classes, the nomenclature being given in this as in all the other divisions, and finally a list of variously named files is appended in alphabetical order, designated according to peculiarities of shape, methods of manufacture, purposes for which used, etc. The definition of file is typical of many hundreds of definitions which lend themselves to systematic treatment. The advantage of this is obvious. A person looking up a definition of *tumbler file,* for example, in its vocabularly place in the book is referred directly to the main definition of *file.* Here a *tumbler file* is defined as "a thick, taper, double-cut, oval file, for shaping gunlock tumblers." This may not seem very informing, as the terms *taper, double-cut* and *oval* are all technical as applied to files, but the definitions of all these terms are to be found under the main entry *file,* so that no further turning over of the pages of the book is necessary. The type arrangement has been carefully thought out and designed so as to economize space to the utmost while allowing readiness and convenience for reference. Three principal sizes of type are used, the largest for the main entries, the intermediate size for such matter as is arranged under these entries, or for two or more word phrases, and the smallest for cross-references and terms of minor importance which are put at the bottom of the page separate from the main vocabulary. Space saving, to accommodate the enormous number of new words which have been added to the language in the last decade or so, as well as a large number of old terms not previously recorded, has been reduced to a fine art in the compilation of the New International, in order to keep it within the confines of a single volume. The book is the result of many years' work of a large staff of experts under the general supervision of the late Dr. W. T. Harris, a scholar and metaphysician of the first rank, and who was for many years United States Commissioner of Education. The office force was under the direct control of F. Sturges Allen, who combines with his lexicographical knowledge a large executive ability. The effect of Mr. Allen's highly analytical and constructive mind is plainly discernible by the splendid coordination of the various departments. The stamp of his legal training is directly noticeable in such definitions as *motor cycle, motor car, tool,* etc., and less directly, but none the less certainly, in the principal mechanical definition of *machine* (def. 5, p. 1291) and other terms. These definitions, of course, were handled in their proper department, but Mr. Allen's criticisms and suggestions were responsible, as in many similar cases, for their correct legal aspect. Such supervision gives the International a unique legal value. No less attention has been paid to the scholarliness of the work, want of space alone preventing a review of this feature. The department of electricity was handled by Dr. Frederick Bedell, professor of applied electricity in Cornell University, and the allied department of physics by Dr. Edward L. Nichols, formerly professor of physics at Cornell and now principal of Dartmouth University. These names are a sure indication of the value of the electrical definitions. In this department many hundreds of new terms have been included, and many of the older terms have for the first time been given a correct and sufficient treatment. The definitions of *induction* and *phase,* picked at random in the book, are veritable little treatises, these terms having been handled systematically, as explained at length above. In fact, it may be said that the New International, taken as a whole, is the newest, most complete and scholarly, in fine, the largest and best, of modern English dictionaries (excluding the mammoth New Oxford Dictionary, which is still in course of publication). Engineers will want it for its mechanical and electrical definitions. A word of praise is due to the many excellent illustrations, while the printing and binding are indeed worthy of the contents and a credit to the Riverside Press, of Cambridge, Mass., which was responsible for these features.

**"Natural Sources of Power." By Robert S. Ball. D. Van Nostrand Company, New York, N. Y. Cloth, 348 pages (5¾x8 inches), illustrated. Supplied by the ELECTRICAL REVIEW AND WESTERN ELECTRICIAN for $2.**

This book covers two departments of engineering and their applications to industry. While the subject of waterpower would be conceded to be more important than that of windpower, the latter has a wider application at the present time than is popularly assigned to it, for the advancement for windmills was never so great as it is today, nor the trade of the manufacturer of such motors never so brisk, but there are unmistakable signs of abnormal expansion in the direction of their useful application in the great agricultural countries of the world. No attempt is made to appraise the relative value and the industrial worth of two natural sources of power so widely different in distribution and reliability; moreover, in a given place the choice rarely lies between the two, as local conditions determine the preference should an alternative, perchance, exist. It may, however, be said that the use of power of either kind in small installations renders such comparisons more likely to be effective, for, at present large windmill installations do not exist, with which waterpower plants of great power might be compared. The various chapters cover in detail the applications of both water and wind, various industries, together with the types of machines and appliances best fitted for the particular service. The text is exemplified throughout with diagrams and illustrations, making the book one which should be of great benefit to students in this branch of engineering. The book is made available to a larger number of readers than would be otherwise, by the fact that the author has made use of only the simpler mathematics.

## FINANCIAL REPORTS OF ELECTRICAL COMPANIES.

### NORTH SHORE ELECTRIC COMPANY.

The North Shore Electric Company, of Chicago, Ill., has issued a financial report for the fiscal year ending September 30, 1909, from which the following data are taken:

To provide funds for the acquisition of additional electric light and power properties for the construction of substations and for the enlargement of the distributing system, the capital stock was increased $220,000 and the outstanding mortgage bonds $285,000.

The earnings and expenses were as follows:

| | |
|---|---|
| Gross earnings | $1,005,432.49 |
| Expenses (including taxes and rentals) | 600,994.56 |
| Earnings for the year | $ 404,437.93 |
| Charges against earnings: | |
| Interest on bonds | $ 190,354.88 |
| Balance | $ 214,083.05 |

From this balance must be deducted a special depreciation reserve of $75,600 and dividends of $103,552.69, leaving a surplus of $34,930.36, which, added to the $119,969.99 surplus of 1908, makes a present surplus of $154,900.35. The balance sheet of the company is given below:

ASSETS.

| | | |
|---|---|---|
| Plant, real estate, franchises and construction | | $7,864,232.81 |
| Open accounts | | 19,385.11 |
| CURRENT ASSETS. | | |
| Inventory of material | $104,884.35 | |
| Bills receivable | 153,855.85 | |
| Accounts receivable | 218,152.43 | |
| Cash | 249,196.86 | |
| Capital stock subscriptions (Not yet due.) | 25,637.50 | |
| | | 751,726.99 |
| | | $8,635,344.91 |

LIABILITIES.

| | | |
|---|---|---|
| Capital stock outstanding and subscribed | | $4,000,000.00 |
| Five per cent first mortgage gold bonds | | 4,000,000.00 |
| Depreciation reserve (Under the terms of the company's general mortgage.) | | 267,640.00 |
| CURRENT LIABILITIES. | | |
| Accounts payable | $112,804.56 | |
| Bond interest accrued, matured and unpaid | 100,000.00 | |
| | | 212,804.56 |
| Surplus, September 30, 1909 | | 154,900.35 |
| | | $8,635,344.91 |

Note.—In addition to the liabilities given above, the company has taken over certain properties which are subject to outstanding bonds and mortgage loans thereon, as follows:

| | |
|---|---|
| Evanston Heating Company | $125,000.00 |
| La Grange Service Company bonds | 254,000.00 |
| Real estate mortgages | 4,000.00 |
| | $383,000.00 |

The interest on these bonds and mortgage loans has been treated as Rental of Property and has been included in the item of Expenses.

### MONTREAL STREET RAILWAY.

The report of the Montreal Street Railway Company for the month of October compares as follows:

| | 1909. | 1908. |
|---|---|---|
| October gross | $354,007 | $328,608 |
| Expenses and taxes | 178,734 | 168,124 |
| October net | $175,272 | $160,484 |
| Charges | 27,079 | 27,480 |
| October surplus | $148,192 | $133,004 |

### TOLEDO RAILWAY AND LIGHT.

The report of the Toledo Railway and Light Company for the month of October and ten months ended October 31 compares as follows:

| | 1909. | 1908. |
|---|---|---|
| October gross | $ 239,374 | $ 218,074 |
| Expenses | 129,719 | 119,982 |
| October net | $ 109,655 | $ 98,092 |
| Other income | 245 | 187 |
| Total income | $ 109,900 | $ 98,279 |
| Charges and taxes | 75,615 | 71,953 |
| October surplus | $ 34,285 | $ 26,326 |
| Ten months gross | 2,220,810 | 2,082,897 |
| Expenses | 1,263,769 | 1,139,806 |
| Ten months net | $ 957,041 | $ 943,091 |
| Other income | 2,444 | 3,259 |
| Total income | $ 959,485 | $ 946,350 |
| Charges and taxes | 727,818 | 707,696 |
| Ten months surplus | $ 231,667 | $ 238,654 |

### HUDSON & MANHATTAN RAILROAD COMPANY.

The New York Public Service Commission has issued a report covering operations of the Hudson & Manhattan Railroad Company for the year ended June 30, 1909, as follows:

| | | |
|---|---|---|
| Revenue from transportation | | $709,618 |
| Advertising and news privileges | | 33,945 |
| Miscellaneous | | 138 |
| Total operating revenue | | $743,701 |
| Maintenance of way and structure | | 100,577 |
| Maintenance of equipment | | 42,669 |
| Operation of power plant | | 23,486 |
| Hired power | | 159,195 |
| Operation of cars | | 146,028 |
| General expenses | | 58,392 |
| Total operating expenses | | $530,347 |
| Net operating revenue | | 213,354 |
| Net revenue from outside operation | | 560,994 |
| Total net revenue | | $774,348 |
| Taxes accrued | | 68,319 |
| Operating income | | $706,029 |
| Non-operating income | | 18,235 |
| Gross income | | $724,264 |
| Interest on funded debt | $632,967 | |
| Other deductions | 26,927 | |
| | | 659,894 |
| Net corporate income | | $ 64,370 |
| Deficit June 30, 1908 | | 116,820 |
| Deficit June 30, 1909 | | $ 52,450 |

### SECOND AVENUE RAILROAD.

The New York Public Service Commission has issued a report covering the operations of the Second Avenue Railroad Company in the city of New York, receiver, for the period from November 13, 1908, to June 30, 1909, as follows:

| | |
|---|---|
| Revenue from transportation | $491,439 |
| Advertising privileges | 14,833 |
| Rent of track and ducts | 3,232 |
| Total operating revenue | $509,503 |
| Maintenance of way and structure | 33,918 |
| Maintenance of equipment | 131,263 |
| Hired power | 113,274 |
| Operating of cars | 185,489 |
| General expenses | 33,562 |
| Total operating expenses | $497,506 |
| Net operating revenue | 11,997 |
| Taxes accrued | 11,283 |
| Operating income | $ 714 |
| Interest on bank balances | 312 |
| Sale of scrap | 5,084 |
| Total income | $ 6,111 |
| Interest and rents | 44,729 |
| Net deficit for period | $ 38,618 |
| Expenses prior period | 671 |
| Interest on funded debt accrued prior to receivership | 34,133 |
| Deficit June 30, 1909 | $ 73,422 |

### NEW YORK TRACTION.

The New York Public Service Commission for the First District has issued the following statistics in connection with passengers carried and revenues derived from operation in traction lines of New York during the month of August, 1909, as follows:

| | Fare Passengers, Aug., 1909. | Total Rev. from St. Ry. Oper. |
|---|---|---|
| Interboro Rapid Transit | 38,677,838 | $1,995,307 |
| B. R. T. System: | | |
| Brooklyn Union L | 13,933,266 | 727,145 |
| Sea Beach | 386,200 | 20,125 |
| South Brooklyn | 1,182,067 | 63,598 |
| Total L service | 15,501,553 | $ 810,868 |
| Brooklyn Heights | 12,040,249 | 611,231 |
| Brooklyn Q County Sub | 2,151,123 | 111,890 |
| Coney Island & Graves | 252,495 | 12,883 |
| Nassau Electric | 7,569,515 | 389,363 |
| Total Brooklyn Rapid Transit system | 37,514,935 | $1,936,237 |

### LONDON UNDERGROUND.

The associated companies of the London Underground Electric Railways Company report for the month of October compared as follows:

| | 1909. | 1908. |
|---|---|---|
| Metropolitan Street Railway: | | |
| Gross receipts | £ 53,990 | £ 52,337 |
| Working expenses | 27,444 | 28,691 |
| Net receipts | £ 26,546 | £ 23,646 |
| Baker Street & Waterloo Company Railway: | | |
| Gross receipts | £ 15,851 | £ 15,511 |
| Working expenses | 7,708 | 7,508 |
| Net receipts | £ 8,143 | £ 7,913 |
| Great Northern, Piccadilly & Brompton Railway: | | |
| Gross receipts | £ 26,733 | £ 24,798 |
| Working expenses | 14,200 | 14,752 |
| Net receipts | £ 12,443 | £ 10,046 |
| Charing Cross, Easton & Hampstead Railway: | | |
| Gross receipts | £ 17,640 | £ 16,167 |
| Working expenses | 10,017 | 9,772 |
| Net receipts | £ 7,623 | £ 6,395 |
| London United Tramways, Limited: | | |
| Gross receipts | £ 26,151 | £ 30,126 |
| Working expenses | 18,270 | 16,585 |
| Net receipts | £ 7,881 | £ 13,541 |
| Total, all companies: | | |
| Gross receipts | £140,365 | £138,939 |
| Working expenses | 77,729 | 77,398 |
| Net receipts | £ 62,636 | £ 61,541 |

### PHILADELPHIA COMPANY GAINS.

The gross receipts of the Philadelphia Company and affiliated corporations for October were $1,641,004, an increase of $344,574, or seventeen-and-one-half per cent over the same month last year. For seven months ended October 31, the gross was $10,365,007, an increase of $1,230,394. The surplus over charges was $1,232,693, an increase of $323,179.

### ORANGE COUNTY TRACTION.

The Orange County Traction Company, of Newburgh, N. Y., reports for the quarter ended September 30, 1909, gross earnings of $67,801, against $62,155 last year; net earnings, after expenses and taxes, amounted to $26,438, against $33,480 last year, and there remained a surplus, after charges of $18,481, against $24,364 last year.

# INDUSTRIAL SECTION

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS

**Installation of an Intercommunicating Telephone System in a Jewelry Manufacturing Plant.**

The application of telephone intercommunication in a plant which has factory and offices adjoining is well illustrated in a recent installation of an intercommunicating telephone system at the plant of Charles M. Robbins & Company, wholesale jewelers, located at Attleboro, Mass. This company does a large jewelry business, including the making of fraternity badges and college emblems, as well as other articles of a more common nature. Due to the conditions under which the material must be handled at this plant, the different departments are somewhat separated and distributed over a considerable space. The telephone instruments, therefore, connected to this system are scattered throughout the factory and the various branches of the general offices, so that the whole plant is interconnected for information of any sort.

The photographs which are here shown illustrate the type of instruments which have been installed, and the general use of the different types to each of the locations.

The type of instrument used in the manager's office is a convenient hand set, which can be used at the desk where a long-distance telephone is required and where two desk sets would occupy considerable space. This set consists of a receiver and transmitter mounted together in such a way as to be operated while held in one hand. When not in use it may be suspended from a hook at any convenient place.

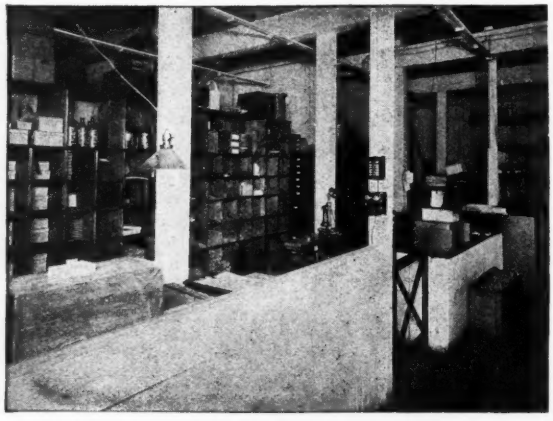
The organization of Charles M. Robbins & Company is such that each department is in itself a separate organization, with a manager. Each of these department managers reports to a general management, so that it is here that the advantages of intercommunication are readily seen.

The intercommunicating system installed at the above plant is so arranged that each station is interconnected with every other one. Waste of time is eliminated, and the whole organization brought together as a co-operative unit.

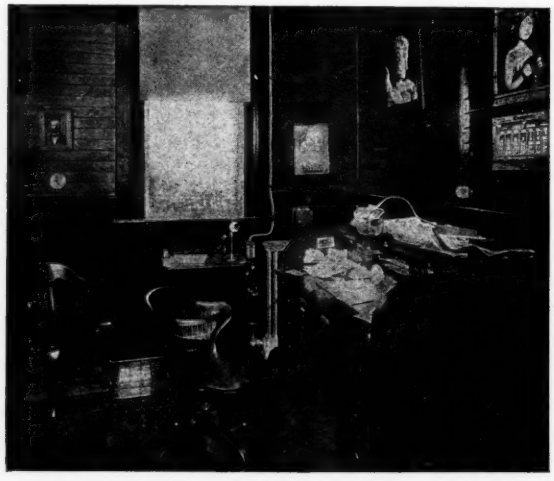
The operation of a system of the nature installed is one of the features which has received considerable attention by the designers and engineers of the Western Electric Company, the manufacturers, and has been made as simple as possible. Each of the types shown in the illustrations is used for the same service and is operated exactly the same. To secure telephone connection with the different stations to which these instruments are connected, it is only necessary to press the proper buttons. One button is mounted on the face of each of the key boxes, shown for each of the stations connected to the system, and a nameplate is provided with space opposite each button for designating the name or location of the station associated with the button. To make a call, therefore, all that is necessary is to press the button opposite the name of the station desired. The act of pressing the button rings and connects the party, and you talk as with the ordinary telephone instrument. The system is always available for use, since, as already seen above, no operator is required.

The illustrations show only hand and desk sets. There is, however, installed at the other stations, wherever these sets are not deemed the most convenient, a wall type of instrument. These sets are self-contained and operate similar to the desk and hand sets shown. The transmitter and key connections are mounted in the same case, so that when attached to the wall the instrument is operated from a standing position. Telephone instruments of the character shown are made of such a capacity as to accommodate either eleven, twenty-one, or thirty-one stations, and in three different styles—one for wall mounting, one for desk use similar to the long-distance set, and a special hand set, which is very convenient in many cases where room for the desk set is not available.

In connection with the wiring of the equipments of this system, the conductors both for ringing and talking extend throughout in cable, the conductors being provided with double-silk and single-cotton insulation, colored for identification. In damp interior locations, when not made fireproof by protecting conduits, the cable has a lead cover.



TELEPHONE IN STOCK ROOM.

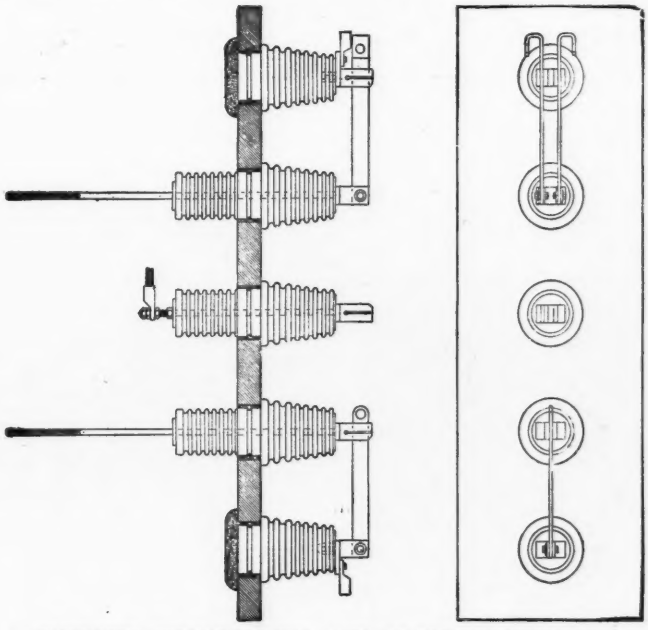


TELEPHONE IN MANAGER'S OFFICE.

For ringing purposes, when the maximum distance between any two stations is 1,300 feet or less, the battery used is sufficient to give a potential of about seven volts with a talking battery of about four volts. With 1,600 feet as a maximum distance, a nine-volt ringing battery is used and a four-volt talking battery. It is, therefore, seen that since no operator is required, the expense connected with this system is largely maintenance, consisting of battery supply. This expense, when standard telephone batteries are used, is very low.

### Combined Disconnecting and Transfer Switch.

The requirements of modern distributing systems necessitates more flexible and better selective control than is afforded by the usual system of circuit-breakers or switches; a need which has resulted in the development of many special forms of switching devices. In many cases it is important that these auxiliary devices not only possess the desired flexibility, but that they are of such dimensions that they will not interfere with existing apparatus, which might be difficult or impossible to change.



COMBINED DISCONNECTING AND TRANSFER SWITCH.

A recent requirement for combined disconnecting and transfer switches was met by the design illustrated herewith. The lower switch is of the single-pole, single-throw type, and arranged to be connected in series with the lightning arresters, thus permitting the arrester circuit to be opened for inspection and replacement of arrester units. The upper element of the device consists of a double-blade, single-pole, double-throw transfer switch, enabling connection to be made to either the upper or lower contacts, as desired.

By use of a double set of lever blades and contacts it is possible to transfer the circuit without interrupting it or subjecting the switch to destructive arcing. It will be noticed that the switch is a combined front and back-connected device and the lever blades are provided with offset extensions, thus permitting them to be operated in the usual manner by means of an insulated pole, or hook. This combined device, developed by the Central Electric Company, of Chicago, Ill., has a carrying capacity of 300 amperes at 13,200 volts.

### A Fire and a Quick Installation.

Not all telephone companies can yet enjoy that sense of security that comes with the housing of their equipment in a fireproof telephone building. In spite of precautions taken, a number of exchanges are burned out every year, and there is scarcely a manager in the country who has not worried more or less over this possible interruption to his service, with its attendant loss both of revenue and prestige.

One of the difficulties looming before the average manager in connection with a possible fire is that of securing a suitable switchboard with any reasonable degree of promptness. However, the promptness with which the Kellogg Switchboard and Supply Company, of Chicago, replaced a board destroyed by fire recently would seem to indicate that the cause for worry in this respect should be lessened.

Immediately following the total destruction of its central office by fire, the Lamar & Barton County Telephone Company, of Lamar, Mo., placed an order with the Kellogg Switchboard and Supply Company for a new 300-line, two-position magneto switchboard, a main frame and No. 10 protector equipment, and a Kellogg pulsating and alternating-current, pole-changer ringing equipment. This order was received at Chicago the afternoon of Thursday, November 11. On Saturday afternoon, November 13, the entire equipment was shipped by express, forty-eight hours after receipt of the order. The express company made delivery of the equipment at Lamar, Mo., late Sunday evening. The Kellogg company was advised of the arrival of the equipment, and two of its installers, stationed at Kansas City, left for Lamar Monday morning. Before midnight of the same day the equipment had been installed ready for operation by the telephone company.

The building, shipping and installation of this equipment in three working days becomes the more interesting when it is learned that the board was not in stock, but was assembled and wired complete and built to the telephone company's specifications. The board is fitted with the Kellogg company's double supervisory non-interfering cord circuits throughout. All cord circuits are provided with two ring-off drops and two cord-circuit condensers, while ten of them contain, in addition, four-section repeating coils for the proper and efficient connection of grounded and metallic lines.

Each position of the board is provided with master keys for ringing four party selective telephones to ground. In this connection a special circuit was provided whereby this selective ringing feature does not require the grounding of the atlernating current, and the latter is left free from ground for the proper ringing of metallic toll lines and "phantom circuits." Each position of the board is furthermore equipped with line and supervisory pilot lamps.

The Detroit United Railway has acceded conditionally to the city's demand for $300 per day for the use of streets upon which franchises are said to have expired. The company specifies that it waives no rights and that the city waives none as regards an ultimate readjustment.

### Arc Lamps for Various Phases of Illumination.

The accompanying illustrations show a number of widely varying conditions of illumination which have been successfully met by the installation of flaming arc lamps.

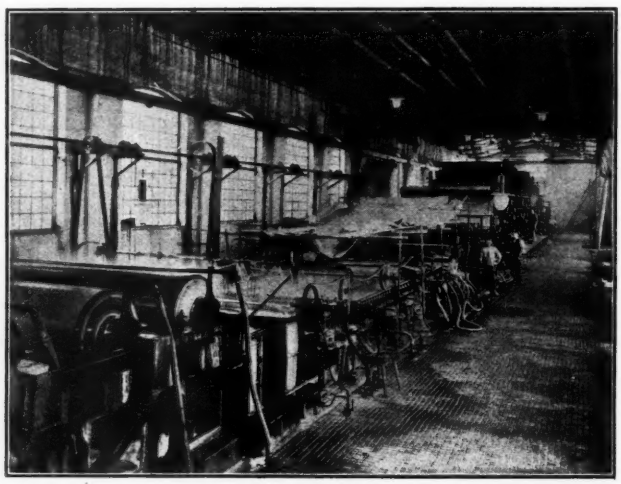
Probably the most unique of these installations are those shown in the two upper illustrations, which demonstrate, respectively, the interior illumination of a paper-making plant and a retail store for the distribution and sale of game.

In the case of the paper-making plant Alba lamps are used, and it may be pointed out that so necessary is a high degree of illumination that the powerful arc lamp is brought down very close to the work.

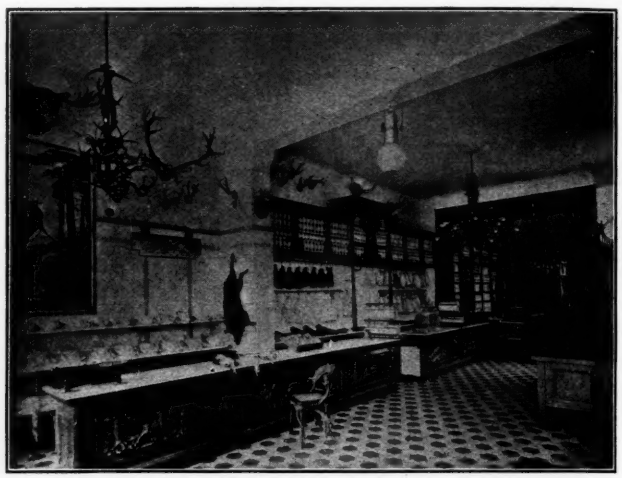
The lamp in the retail store is a ten-hour Alba, and in this service it is working with a high degree of satisfaction.

Two of the other illustrations show some of the architectural features of two prominent points in the city of Milwaukee, Wis. In the one instance the Aurola lamps are used for general illumination at a point just where Wisconsin Street crosses the bridge over the river. In the other, Aurola lamps are used for illumination in front of a popular restaurant, and in this case the cable carrying the lamp from an ornamental standard is passed over sheaves to a reel placed at a convenient height on the front of the building.

Another illustration shows a very effective installation of Alba lamps in Berlin, Germany, where the lamp is placed at a great height upon an iron standard for general park illumination.

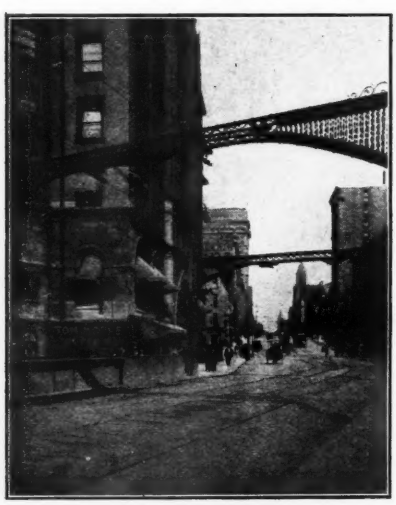


Paper-Making Plant.



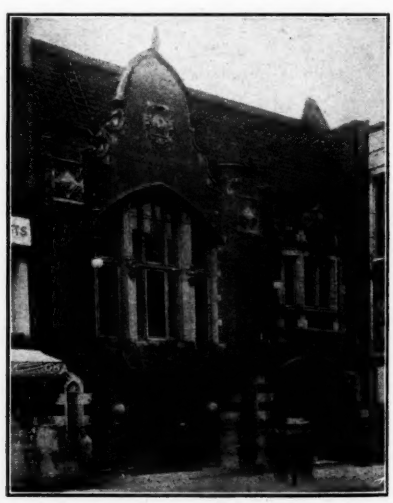
Fowl and Game Market.

INDUSTRIAL INSTALLATIONS OF ALBA FLAMING ARC LAMPS.



Wisconsin Street Bridge, Milwaukee.

Park Illumination in Berlin.



A Well-Known Milwaukee Restaurant.

TYPICAL INSTALLATIONS OF AUROLA AND ALBA FLAMING ARC LAMPS.

### Allis-Chalmers Sales of Pumping Machinery.

The sales of the pumping-engine department of the Allis-Chalmers Company, of Milwaukee, Wis., for the past month are interesting as an indication of the various types of pumps now going into service. Most of the smaller capacity units are of the centrifugal type, while the high-duty pumps are of the direct-connected engine type.

Among a long list of recent sales, Chicago has ordered two 25,000,000-gallon (daily) vertical expansion pumping engines for its Roseland pumping station and Wheeling (W. Va.) a 20,000,000-gallon triple-expansion pumping engine to reinforce its municipal supply.

Niagara Falls, N. Y., has ordered three 6,000,000-gallon single-stage and six 6,000,000-gallon two-stage centrifugal pumps with electrical drive, to be used in the new muncipal waterworks. The Paine Lumber Company, of Oshkosh, Wis., is getting two two-stage electrically driven centrifugal pumps for use in connection with its condensing system.

## WHAT CONSTITUTES A GOOD LUBRICANT?

BY ORRIN E. DUNLAP.

In the issue of the ELECTRICAL REVIEW AND WESTERN ELECTRICIAN of September 25 there appeared a most interesting article entitled, "What Constitutes a Good Lubricant?" The headline of itself arouses great interest, because the question it asks is one which many have for years been trying to solve, each one anxious for knowledge of the best lubricant suitable for various fields. Had this question been asked sixty years ago it would have met with a different answer from that it receives today.

It is well known the past generation used animal fat for lubrication, the present generation is using petroleum oil. We are told by those who seek to conserve our natural resources that the supply of lubricating oils will barely last another fifty years. This is, indeed, a comparatively short period, and it is none too early to take into earnest consideration and proceed to adopt a lubricant which will replace all others in appreciation and service. That the lubrication of the present day, as supplied by many of the oil and grease lubricants in use, is quite imperfect, is told in the article to which reference is made, which says, "Melted grease stays in the bearings no better than oil. It leaks away and must be constantly replaced by a fresh supply." The question is asked, "Where shall we find a lubricant which both offers a low and constant coefficient of friction and does not tend to leave the bearings before it has done its work?" This question is easily answered. The solution is given in the paragraphs proceeding that from which I quote, where it is stated that graphite has a tendency to remain in the bearing while the fatty constituents melt and run away. This brings us to a realization that unctuous, pure graphite is the lubricant on which we must depend for highest efficiency and best results.

Graphite lubrication has been retarded in its popularity by the impurity always found associated in natural graphite, but the objections developed by this inferior graphite are more easily overcome than are the objections to inferior oils or greases. It is true that here in Niagara Falls man has developed a process which has given to the world a very soft, pure, unctuous graphite that has a guaranteed purity of at least ninety-nine per cent. This very high and remarkable purity is assurance to all that a practically pure graphite is available for use in the field of lubrication. Furthermore, the makers of this graphite have advanced still further in making it possible for industry to avail itself of the lubricating qualities of this graphite by combining it with a high-grade grease which acts as a carrier for the graphite and makes it possible to carry it into bearings requiring lubrication. The inventor has also discovered a process whereby this unctuous graphite is deflocculated and made to remain in suspension in oil or water, in which form it is easily fed through any of the present-day oiling devices.

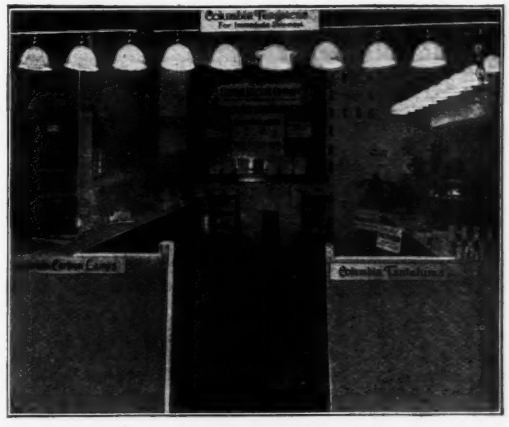
"What is to insure maintaining a sufficient film?" is another question asked in the most interesting article. The answer is, "The use of unctuous graphite will insure a film or coating that will afford perfect lubrication. This is particularly true if the graphite used be unctuous, pure and soft, not crystalline nor hard, for it will with great ease adjust itself to the microscopical irregularities of the surface, filling up the hollows and burying the points, thereby producing a mirror-like surface of great density quite capable of withstanding continued wear and affording the highest form of lubrication. Under pressure the graphite will move within itself like a film of oil, making it quite impossible for bearings so lubricated to seize or cut. Those familiar with oils as lubricants are aware that an oil on examination may seem to possess all the essential qualities, but that those qualities when in use become wholly changed.

Unctuous graphite, on the other hand, is a lubricant that will not deteriorate, emulsify, oxidize or burn up, factors of importance which make unctuous graphite a dependable lubricant, sure to render efficient service on heavy or light machines, on large or small bearings, as required.

It is also true that a large percentage of fires in cereal, textile and other mills come from overheated bearings. In all such establishments unctuous graphite will tend to conserve the element of safety in fire risks, for it should be understood that unctuous graphite is made in Niagara Falls in a temperature of over 7,000 degrees Fahrenheit, and that its lubricating properties cannot be impaired by any degree of heat likely to develop in hot bearings, due to extraneous heat or other causes.

### Central Electric Exhibit at Illinois State Convention.

One of the most artistically decorated booths at the last convention of the Illinois State Electric Association that was held at Alton, Ill., on October 26 to 28, was that of the Central Electric Company, of Chicago. By the use of tungsten lamps and Opalux reflectors a soft, uniform illumination was secured which materially added to the attractiveness of the booth. As shown in the accompanying picture, the display of Opalux glassware formed a striking feature of the exhibit. Opalux is a new type of reflector, having its diffusing surface on the reflecting side. Opalux glass is perceptibly translucent, but a new method of manufacture has been devised which produces a diffusing surface entirely different from that produced by the ordinary etching, sand-blasting or enameling. While the glaze of the glass has been entirely removed, the surface is of such a high degree of smoothness that it can be cleaned as readily as other glass and at the same time does not give sufficient direct reflection to produce perceptible glare. The absence of glare in connection with this particular display was especially noticeable.



CENTRAL ELECTRIC EXHIBIT AT ALTON.

### Large Wire Plant for the South.

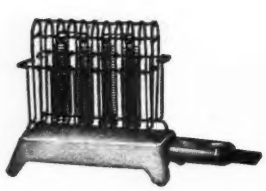
The American Steel and Wire Company has been authorized by the directors of the Steel Corporation to construct wire mills at a point near Ensley, Ala., having a capacity of 400 tons per day. The appropriation is $3,000,000. This new plant has been considered for some time, on account of the large demand for wire in this section. New orders and specifications for the first half of November averaged 7,500 tons per day, or 500 tons per day in excess of the total output of all the mills of the company.

### Electrically-Heated Devices for Holiday Trade.

Electrically-heated devices have passed the experimental stage and are now well established as part of the equipment of a modern household. There is no disputing their superiority as to cleanliness, convenience and attractiveness.

An impetus has been given the sale of the popular household devices, such as percolators, chafing-dishes, tea-kettles, etc., owing to the fact that a large choice of designs is now available. Hitherto manufacturers have taken one or two styles of heating devices and equipped them electrically. Arrangements have now been made with a large manufacturer to equip his most popular and attractive designs with General Electric units, and a choice of thirty designs and finishes of electric percolators tea-kettles and chafing-dishes will be ready for the holiday trade.

There are a number of novelties in the electric heating line, prominent among which is the new radiant toaster. This is a fascinating device. Toast may be made on the dining table, at the bedside or wherever electricity is available, and the whole operation is visible. On turning on the switch the wire heats up to a white heat instantly. The toasting process is at all times under control.



RADIANT TOASTER.

CIGAR LIGHTER.

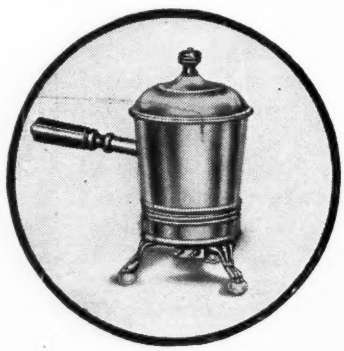
The electric cigar lighter is a very attractive device. The continuous pendant type is intended for continuous service in cigar stands and similar places and operates an entire day at a cost of less than two cents.

The new design of General Electric water heater, shown in the accompanying illustration, will be found of great usefulness in a thousand different ways. It may be used as a milk warmer, egg boiler or for heating liquids generally. It is made of copper, heavily riveted and is available in pint and quart sizes. A larger size of heater for two, four or six quarts is suitable for preparing an entire dinner. A range of three heats allows satisfactory regulation of the thermal effect.

Disk stoves are rapidly being adopted for small households. These stoves are remarkably quick and efficient, being of the encased disk unit type. These new stoves are able to operate at a much greater activity (watts per square inch) for a given size than electric stoves have formerly been. This is due not only to radical improvements in the design or application of the heating elements, but also to the material and construction of the heating element itself.

### Underground Transformers.

The Oerlikon Company constructed some time ago a new type of transformer intended for installation underground. These transformers are easily accessible, and do not interfere with the traffic and disfigure the appearance of the street like those installed above ground. An oil-filled case of riveted sheet iron with a tightly fitting cover contains the transformer proper, which is of the core type. The cables are led in through two diametrically opposite openings sealed by an insulating mass, in the upper part of the case. Up to these openings the transformer is surrounded by gravel, which readily takes up the rainwater flowing from the curved cover. The entire apparatus is installed in a cement manhole with four flow-off channels in the bottom for removing water. A more or less strong cover, according to whether the transformer is installed under the street or sidewalk, closes the manhole. Oil vapors can escape through a suitable valve. Switches and fuses may be installed in other oil cases alongside of the transformer, or else such accessories for all the transformers of a zone may be united in a central station, whence the high-tension current is then conducted to the transformers. The high-tension conductor is a single cable with two concentric conductors; for the low-tension, two separate cables are provided.—*Abstracted from Journal fuer Gasbeleuchtung (Munich), October 16.*



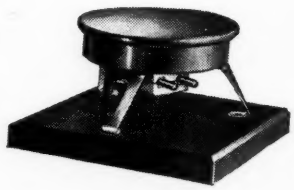
WATER HEATER.

### Electrical Equipment for a Large Shop.

Among the orders received recently by Allis-Chalmers Company, of Milwaukee, Wis., is one from the Starr Manufacturing Company, of Carpentersville, Ill., which is one of the well-known manufacturers of steel shapes, and is arranging to install electric shop drive by induction motors.

This order includes a 300-kilovolt-ampere, 480-volt, three-phase, sixty-cycle alternating-current generator, direct-connected to a 380-horsepower twin vertical open-flume hydraulic turbine. The turbine will operate under a seven-foot head, and will be regulated by an oil-pressure governor. Excitation for this hydroelectric unit will be by means of a 22.5-kilowatt motor-generator set.

The order also covers a similar generator of the engine type, which is to be driven by a steam engine now installed in the plant. This generator will be excited by a thirteen-kilowatt, 120-volt exciter driven by a belt from the generator shaft.



DISK STOVE.

COFFEE PERCOLATOR.

A total of fifty-two 440-volt induction motors will be installed about the plant, and a nine-panel switchboard of blue Vermont marble, with complete equipment of the latest design, will hold the control and recording apparatus. All of the machinery and auxiliary equipment named above will be of Allis-Chalmers make.

### The British Electrical Industry.

About 31.5 per cent of the heavy electrical plant manufactured in Great Britain is exported, while 16.0 or 17.0 per cent of the total home consumption is imported from foreign countries. One-half of the electrical fittings, and more than half of the metal-filament lamps, used in Great Britain, are also imported, while in other lines of electrical industry the British manufacturer is not able to monopolize his own home market. These facts were given by R. K. Morcom in an address to the Birmingham (Eng.) Section of the Institution of Electrical Engineers.

# Current Electrical News

## GREAT BRITAIN.

*(Special Correspondence.)*

LONDON, NOVEMBER 20.—The traffic receipts on the District Railway and on the affiliated "tubes" are rapidly increasing. On the District line in October there was an increase of $10,000 compared with October last year, and the corresponding increases in the receipts from the tube railways for the same month were $12,000, $1,150 and $6,500. No doubt the facilities for through booking, which have been brought to a high state of perfection, are mainly responsible for this result.

The Olympia Motor Car Exhibition, which is just about to close, once again demonstrates that no headway is being made in the manufacture of electric motor cars. Indeed, one firm at the show, with an electrical name, does not show an electric car at all. There are only two stands on which electric cars are exhibited. Considerable progress has, however, been made in the electric lighting of cars, and in one case a dynamo is mounted on the shaft of the gasoline engine which draws the car. Other systems involve the use of belt-driven dynamos, while in others accumulators are employed. Electric horns are also becoming popular, and electric headlights are being used to a very large extent. But the field for electric cars still remains undeveloped, although a great many may be seen running about the streets of London.

A marble bust of the late Dr. John Hopkinson was presented last week to the Institution of Electrical Engineers by Mrs. Hopkinson. The new president, Dr. Gisbert Kapp, delivered his opening address at this meeting.

It is announced that the Nobel prize for physics for the past year has been divided between William Marconi and Professor Braun of Strasburg.

The two aluminum companies of Great Britain are being gradually brought to a satisfactory position. A scheme of rearrangement has been passed by the creditors and shareholders of the British Aluminum Company, under which a new company will be formed and the majority of the creditors will take shares in liquidation of their claims. In the case of the aluminum corporation negotiations for reorganizing the undertaking presents such a satisfactory outlook, that two petitioning creditors for a compulsory winding up have agreed to allow their petitions to stand over until the next legal sittings.

A new bridge, to carry tramways and to have one carriageway, is to be built across the Thames, close to St. Paul's Cathedral. The cost is estimated at $8,250,000.

A good deal has been heard at various times regarding the application of wind power for dynamo driving, but not a great deal has been done in this direction in this country. One famous instance, some fifteen years ago, was in London, where a well-known miller erected a windmill of American manufacture upon the roof of his premises. This mill drove a dynamo which supplied current for lighting and for operating an electric elevator. But the London County Council succeeded in bringing the structure within the Sky Signs Act and down it had to come. Since then a few installations of a similar character have been erected for country house lighting. An installation of this kind has just been completed in Worcestershire where a twenty-four-foot wheel on a seventy-five-foot steel tower drives a small dynamo. The house is some 500 yards away, and the energy is conveyed from the dynamo room, in the foot of the tower, to the house by means of overhead mains. Metal-filament, twenty-five-volt lamps have been installed. There is a twenty-eight-cell battery used with this installation.

The Royal Society, in its annual distribution of medals, has awarded Dr. R. T. Glazebrook a Hughes medal for his work on electrical standards, and Sir James Dewar a Davy medal for his work on low temperatures.

In spite of the refusal of the London County Council a short while ago to grant the Marylebone Council a loan for converting a large number of street gas lamps to electric lamps, the work has been carried out and is being paid for out of revenue. Further, it has been demonstrated that the cost is cheaper than gas, with a better light. Emboldened by the success of the experiment, the Marylebone Council proposes to go further and lay mains for lighting all the remaining streets of the Borough by electricity, and a loan of $125,000 is to be asked for for this purpose.

A British Association of Medical and Electromedical Instrument Manufacturers has been formed in London.

Conciliation Boards have been formed by the London County Council to deal with any grievances which the tramway employes may have. The Council and the men nominate an equal number of representatives. Boards will be formed to deal with traffic, rolling stock, electrical work, permanent way and buildings. There will also be a Central Board.

I have just heard of a big scheme for amalgamating the Yerkes group of tube railways in London, in order to bring them under one management instead of having three separate companies as at present. The proposal will be submitted to Parliament next session. G.

## EASTERN CANADA.

*(Special Correspondence.)*

OTTAWA, ONT., NOVEMBER 27.—The earnings of the Mexican Light and Power Company for the year to date are some $350,000 short of the $543,400 necessary to meet common stock dividends. The company, by the end of the year, will have paid out considerably more than it has earned.

There is not likely to be any interference by the federal government with the Ontario government's hydroelectric legislation. The refusal of the Dominion government to yield to the demands of the electric interests is due probably to the popularity of the hydroelectric scheme.

The Canadian Pacific Railway will shortly take an important step toward the abatement of the smoke nuisance in the city of Montreal, so far as it may be caused by railway trains drawn into the city. The means proposed is to transfer the motive power from steam to electricity, at Montreal Junction, so that all trains entering the city will be brought in by high-power electric engines. It is felt that the time is near when all railway lines will be compelled to adopt electric power in drawing their trains into terminals.

The Street Railway company of the city of Kingston, Ont., has stopped operations because the City Council refused to give the company the terms it wanted for the use of electric power. The city offered to provide power at 1.20 cents per kilowatt-hour for five years, with the privilege of terminating the contract at the end of three years if the necessities of the city lighting and power plant required it. The company wanted a contract for five years with the privilege of dissolving it at any time on six months' notice.

Dissatisfied with the change of schedule from twenty minutes to one hour, for the trip between Niagara Falls View and Montrose station, the Stampford Township Council has ordered the Niagara & St. Catherines Street Railway company to restore the former service or tear up its rails and ties. The railway company has been served with notice to this effect, and a fight between the company and the Council, which fought the hydroelectric commission so determinedly, is awaited with much interest.

The demand for Canadian mica is on the increase, and the mica properties in eastern Ontario are nearly all in operation again. In spite of the fact that the recent tariff legislation in the United States has raised the tax on the Canadian article going into the United States, the market there has become large, and it is confidently expected, among the Canadian mica men, that there will be an opening in the United States, in the future, for nearly all the mica that can be produced in this country.

The city of St. Catherines, Ont., has finally succeeded in getting the Canadian branch of the Crocker-Wheeler Manufacturing Company, of Ampere, N. J., located in St. Catherines. This concern manufactures all kinds of electrical machinery and does a very large business in Canada. One large Canadian contract the company has now in hand is for the manufacture of machinery for the big power works at Winnipeg, Man. The contract price is stated to be $250,000 and the machinery will be made at St. Catherines. The company has agreed to start with 100 first-class mechanics, but says that it will be employing at least 1,000 at the St. Catharines works in a few years' time.

President J. E. Aldred, of the Shawinigan Water and Power Company, states that the report that his company is acquiring shares in the Montreal Light, Heat and Power Company, for the purpose of control, is absolutely unfounded. It is true, however, that the Shawinigan company has acquired a substantial interest in the shares of the Montreal concern. The president remarks that it is hardly necessary to comment on the strength of the position of the Montreal company, backed by the Shawinigan company, which still has at its disposal 75,000 horsepower of the capacity of its waterpower, known to be the most perfect and economical waterpower in the world. The harmonious operation of these two companies guarantees to the city of Montreal electric energy for many years, under conditions not excelled in any city on this continent.

That in the Ottawa and the Gatineau valleys there is much undeveloped waterpower, and that there are iron ore deposits,

which could be treated profitably by the new electric furnace method, are two conclusions arrived at by Fritz Cirkel, who has been investigating for the department of mines at Ottawa. In his report, the mining engineer says that pig-iron can be economically produced at a price to compete with the blast furnace product when electrical energy can be produced at less than $7 per horsepower. In this connection, it has been learned that the waterpower at the Chats Falls, on the Ottawa River, near this city, can be developed at a cost of only $4.50 per horsepower per year. In addition to these there are other splendid falls, near deposits of iron ore, such as the falls between Kirks Ferry and Ironsides, on the Gatineau River, within a few miles of Ottawa on the Quebec side. These can develop about 200,000 horsepower and are only two miles distant from large iron mines. The amount of water available for use along the Ottawa and Gatineau rivers has been shown, and steps necessary to harness it have been indicated. A summary of the investigations, with the name of the falls and the horsepower available, shows on the Ottawa River, within a comparatively short distance from the city, eighteen rapids and falls, yielding an estimated total of 306,020 horsepower, and, on the Gatineau, fifteen waterpowers, giving 216,325 horsepower, or a grand total of 522,345 horsepower. W.

## LIGHTING AND POWER.

*(Special Correspondence.)*

ASH GROVE, MO.—This city is planning to install an electric-light plant. P.

CHESAW, WASH.—The Apex Mining Company will purchase a power plant for its mine here. A.

ARLINGTON, S. D.—The Council is figuring on the installation of an electric-light plant to cost from $2,500 to $3,000. C.

LOS ANGELES, CAL.—An ordinance has been passed providing for ornamental lighting of Pico from Main to Vermont Street.

WOODSTOCK, VT.—The Woodstock Electric Company has filed a statement of an increase of its stock from $18,000 to $40,000.

RED BLUFF, CAL.—The Sacramento Valley Power Company has been awarded a franchise to use the public highway for its poles and wires. A.

SALINAS, CAL.—The Monterey County Gas and Electric Company has been granted a franchise for a power line between Salinas and Monterey. A.

DENVER, COLO.—The Champa Power Company has been incorporated, with a capital of $15,000, by H. C. Briggs, William I. Spratt and Huse Taylor, of this city.

PHILADELPHIA, PA.—The Philadelphia Electric Company has secured the contract for lighting the city for the coming year. The city has appropriated $1,182,000 for this purpose.

LONG BEACH, CAL.—The Southern California Edison Company will build a substation in the Belmont Heights district to care for the electricity that will be used in that section of the city for lighting.

VISALIA, CAL.—The Mount Whitney Power and Electric Company has been incorporated, with a capital stock of $5,000,000, by J. C. Hays, T. J. Broidrick, F. G. Hamilton, H. T. Hays and A. C. Chickering. A.

LEADVILLE, COLO.—The Leadville Light and Power Company is building a power house to the Sugar Loaf mining district. It is expected that much of the steam power plants will be replaced by electric installations.

EDGERTON, WIS.—A rural telephone company, which will build a line to connect several homes in the village of Albion with Edgerton, has been organized. William McCarthy has been elected president of the company. M.

NEW YORK, N. Y.—The Ambato Electric Light Company of New York, has been incorporated to deal in electric light, heat and power in Ecuador, South America, with a capital of $50,000. The incorporators are: F. J. Torpey, J. A. Caras, A. Manly, New York city.

LOS ANGELES, CAL.—The Mexican Light and Power Company, which has a monopoly in Mexico City and supplies the El Oro mining district, has decided to build a branch transmission line to Pachuca and deliver current to the mines in that district. A.

PINEBUR, MISS.—The Walworth & Neville Manufacturing Company wishes to buy at once a second-hand direct-current dynamo that is guaranteed to burn 250 bright sixteen-candlepower lights. Machine to be given a test on the work before final acceptance. B.

NEW BRIGHTON, PA.—At the annual meeting of stockholders of the Beaver Valley Traction Company directors were elected as follows: James D. Callery, J. H. Reed, S. L. Tone, W. B. Carson, C. S. Mitchell, J. L. Foster, Theodore P. Simpson, M. D., W. G. Whitlinger, A. M. Stevenson. Expenditures were authorized for $10,000 on the power-house and storage-battery equipment.

HILTON, N. Y.—The Public Service Commission, Second District, has authorized the Hilton Electric Light, Power and Heat Company to issue its capital stock to the amount of $5,000, and has authorized this company to construct a plant and exercise franchises in this village.

STAUNTON, IND.—The Town Board has granted a franchise to the Terre Haute, Indianapolis & Eastern Traction Company to light the town and furnish current for commercial lighting. The company will construct a pole line from the supply wires to the town, a distance of six miles. S.

SAN BERNARDINO, CAL.—The City Council has passed an ordinance granting to the Southern California Edison Company a franchise to construct and maintain piers, masts and poles, and to lay and operate cables, etc., for the transmission of electricity along the public highways of this county. A.

GOLDFIELD, NEV.—Work will soon begin on large power plants in Mono County, which are to suuply power for an electric railroad from Coaldale to Bodie, to connect with the Tonapah & Goldfield Railroad. The water for the plants will be taken from Silver Lake and will furnish about 33,000 horsepower. A.

LEWISTOWN, ME.—President John L. Bright, of the Citizens' Electric Company, has just organized the Spring Creek Power and Electric Company, which will take over some valuable power sites on Spring Creek, one of which, just purchased, was sold for $21,000. The new concern has a capital of $250,000.

OAKLAND, CAL.—D. U. Toffelmire, representing the United Power Company, has applied for a franchise to erect poles and install a system for the distribution of electric light and power in Alameda County. The purpose of this company is to engage in competition with the Oakland Gas Light and Heat Company. A.

TERRE HAUTE, IND.—The Indiana Electric Transmission Company, has given the Secretary of State notice of an increase of directors from five to seven, and an enlargement of field to enable the corporation, which is building a mammoth power plant in the coal fields, to operate or transmit electricity into any county of the State. S.

FRANKFORT, IND.—It has been decided in a recent ruling, that the municipal plant here, has no right to sell incandescent lamp bulbs to its customers. While the case has never come up for trial, Judge Vestal has overruled a demurrer to John S. Kelly's injunction against the city, and the City Council has let the matter drop.

GREENVILLE, S. C.—Transmission lines of the Southern Power Company to the new distributing station bringing current from the Great Falls plant, which were expected to be completed two months ago, on account of delays will hardly start before December 1. Power will be furnished the Monaghan and Woodside cotton mills. L.

ANAMOSA, IOWA—Harry and Frank Zinn, Park Chamberlain and Geo. L. Schoonover sold the electric-light plant, waterpower and all franchises and equipment to A. E. Anderson, of Chicago. Mr. Anderson has also bought the water franchise at Oxford Mills, the electric-light plant at Oxford Junction, which includes the systems at Wyoming and Olin. C.

BRISTOL, TENN.—A company has been formed to construct a hydroelectric power house near this city at a cost of $250,000. Power is to be delivered by this company to the Bristol Gas and Electric Company and distributed by them. The power company is under bond to deliver power to the Bristol Gas and Electric Company not later than July 1.

HICKORY, N. C.—Following announcements of surveys to this point by the Southern Power Company for transmission lines, it is stated that the company is considering extensive developments on the upper Catawaba, near Hickory, and that another transmission line will be surveyed. The company has, however, already contracted to deliver power in Hickory. L.

MISSOULA, MONT.—It is reported that State Senator Ed Donlon of Missoula, candidate for governor on the Republican ticket last year, intends to erect a million-dollar electric-power plant at Thompson Falls in competition with the Washington Water Power Company. Water rights and a site have been acquired and the territory of the Washington Company will be invaded in Idaho, Washington and Montana.

COSHOCTON, O.—The Coshocton Light, Heat and Power Company is placing contracts for over 1,200 horsepower addition to its plant for power purposes and next spring will start work on a hydroelectric plant of over 1,000 initial horsepower, the waterpower being obtained from the state dam in the Walhonding River. Mr. Heimbaugh, president of the company, says that contracts have been made for practically all of the power which will be developed by the new plant.

## ELECTRIC RAILWAYS.

*(Special Correspondence.)*

WATERTOWN, S. D.—An electric line to Fargo, via Sisseton, Hankinson and Wahpeton is projected. C.

SCOTTSBURG, IND.—Preliminary surveys have been made of the Cincinnati, Madison & Western traction line from Scottsburg to Madison.

FRESNO, CAL.—An ordinance has been passed granting a franchise to the Fresno Traction Company to construct and maintain a street railroad. A.

SAN JOSE, CAL.—The Peninsula Railroad Company has sold its fifty-year franchise on the First Street line and auxiliaries for $16,000 to L. E. Hanchett. A.

ANOKA, MINN.—An ordinance has been passed granting a franchise for a street railway to the Anoka-Minneapolis Suburban Railway Promotion Company. C.

CHARLES CITY, IOWA—Arthur Dennis, secretary Commercial Club, is trying to interest capital in the construction of a street railway to Greene, Iowa. C.

PETALUMA, CAL.—The Highland Pacific Electric Railroad is procuring rights-of-way to operate an electric line from Lakeport to Santa Rosa via Cloverdale. A.

JACKSONVILLE, ILL.—Work on the Jacksonville-Springfield railway has begun. The stockholders are O. J. Lucas, D. H. Sims, S. H. Cummins and T. S. Davy.

SAN FRANCISCO, CAL.—The Stockton Street Railway franchise granting a right-of-way from Market Street to the Presidio has been awarded to Frank D. Stringham. A.

WINNECONNE, WIS.—The business men propose to raise $5,000 for the immediate construction of an electric line to Oshkosh, to be later continued to Waupaca. C.

BERKELEY, CAL.—The Key Route Company will begin work at once on its new Sacramento Street line. The line will be double tracked and will cost about $3,000,000. A.

VIRGINIA, MINN.—W. M. Prindel, of Duluth, and J. D. Chapman, of Chicago, have applied to the Council for a franchise to build an electric line to Gilbert and Eveleth. C.

PRINEVILLE, ORE.—Arrangements have been made for the survey of an electric railway between here and Opal City, a new townsite between Trail Crossing and Culver Road. A.

ONTARIO, ORE.—D. G. Sutherland, of this city, has applied for a franchise to build an electric railway in this city. The franchise will be offered for sale on December 14. A.

LOS ANGELES, CAL.—W. M. Bowen has purchased from the county an electric-railway franchise to extend from city limits on W. Adams Street to Washington Street in this city. A.

FRESNO, CAL.—F. S. Granger has been granted the franchise recently applied for by him for terminals in this city for his proposed interurban line between Fresno and Hanford. A.

SAN DIEGO, CAL.—The San Diego Electric Railway Company has petitioned the Council to advertise for bids for a street-railway franchise on Thirteenth Street from K to L streets. A.

WINONA, MINN.—The La Crosse and Winona Traction Company has petitioned the Council for a fifty-year franchise to build and operate an interurban electric railway to La Crosse, via Galesville. C.

BLUFFTON, IND.—The directors of the Bluffton, Geneva & Celina Traction Company have abandoned the idea of using motor cars and will install an overhead trolley system on its new road. S.

LAUREL, MONT.—W. R. Westbrook and L. A. Nutting, of Laurel, and others, have incorporated a company to construct an electric line to Billings and up Clark Fork and Rock Creek. C.

MINNEAPOLIS, MINN.—The Twin City Rapid Transit Company is considering the erection of a new barn and repair shops at Layman Avenue and Lake Street, to cost $400,000 to $500,000. C.

SIOUX CITY, IOWA—The survey for the proposed electric road to the Bijou Hills, S. D., has been completed as far as Parkston, S. D., which town subscribed $50,000 toward the enterprise. C.

WILMINGTON, DEL.—The Ohio, Kentucky & Atlantic Railroad Company has been incorporated by J. F. Varcoe, Brooklyn, N. Y.; W. N. Akers, W. J. Maloney, Wilmington, Del. The capital is $50,000.

ELKHART, IND.—The Indiana and Michigan Electric Company is now furnishing current, on a contract for fifteen years, to the Chicago and South Bend and Northern Indiana Railway Company to operate their interurban cars. The power is generated at the Hen Island plant, on the St. Joseph River, and is now moving all of the interurban cars of the traction company from Michigan City to Goshen, and all of the local cars in Goshen, Elkhart, Mishawaka and South Bend. This service was begun November 19. S.

WABASH, IND.—Wabash County has voted $50,000 subsidy to aid the Wabash & Northern Indiana Traction Company in building its road from Wabash to North Manchester and Warsaw. Kosciusko County voted $7,500 to the same end.

LA CROSSE, WIS.—W. J. Ferris, president of the La Crosse Water Power Company, states that construction on the interurban line to Winona will be started in the spring, there already being $1,000,000 available for that purpose. C.

TOLEDO, OHIO—The new Fremont & Fostoria Electric Railway has acquired the Fremont Street Railway lines, for entrance into the city of Fremont, Ohio. Grading will soon be under way and the bulk of the work will be done this winter. H.

BRISTOL, VA.—An electric line is to be built through Lee and Wise counties, in southwest Virginia, by Canadian capitalists. Engineers have been employed and it is reported that work on the interurban electric line will be begun in a short time.

MUSCATINE, IOWA—The final survey of the new line of the Muscatine North and South Railway extension from Elrick Junction to Burlington is now being made. A party of surveyors left Muscatine early last week and are now working out of Oakville.

NEW CASTLE, IND.—The engines and other equipment for the power house of the Indianapolis, New Castle & Toledo Traction Company have arrived and are being installed rapidly. The company's road-bed is being ballasted and plans are to open the line by Christmas. S.

SALT LAKE CITY, UTAH—Officials of the Salt Lake & Los Angeles Railway Company have announced their intention of electrifying the line to Saltair during the coming summer. A franchise permitting the use of electric cars on the present steam road has been asked.

WABASH, IND.—W. L. Moyer, who is promoting the Wabash & Northern Traction Company, to run between Wabash and Warsaw, announces that contracts have been let for all the material, supplies, etc., except the overhead work and equipment. Work on the road will begin January 1. S.

KINGMAN, IND.—A generator and other power-house equipment have arrived and the work of installing them in the new power house will begin at once. J. J. Barnes, president of the Covington & Southwestern Traction Company, says that he hopes to complete the road in a few months. S.

HOUSTON, TEX.—M. M. Phinney, manager for the Stone & Webster syndicate here, recently announced that the construction of the Houston-Galveston interurban line will be commenced by January 1, and that the line will be in operation by the time the Galveston causeway is completed.

LA CROSSE, WIS.—The $3,000,000 electric interurban between Winona, La Crosse and Sparta will be completed and in operation by next fall, according to a statement issued by W. J. Ferris, president and general manager of the La Crosse Waterpower Company, which is behind the project.

JERSEY CITY, N. J.—The Ottoman-American Development Company has been incorporated to construct railways, electric lighting, telephones, sewers, etc., with a capital of $100,000. The incorporators are: D. E. Peck, A. T. Chester, L. G. Billings, Jr., G. E. Schultze and R. S. Wolfe, Jersey City, N. J.

CHATTANOOGA, TENN.—The Chattanooga Railway and Light Company has filed a mortgage for $15,000,000 in favor of the Fidelity Trust Company, of Philadelphia. Of this amount $10,610,000 will be used for extensions and new equipment and the remainder in retiring the bonded indebtedness.

LAUREL, MONT.—The Eastern Montana Electric Railway Company is asking for a franchise to build a street-car line in the city. It is proposed to build a line to Billings and extend it west to Red Lodge, crossing the hill to Bearcreek and returning to Laurel by a loop, embracing the entire Clark Fork Valley. C.

PENDLETON, IND.—The Indiana Union Traction Company is purchasing an additional thirty feet of land along its right-of-way and will soon enter upon the work of building a double track between Anderson and Indianapolis in order to accommodate the increasing number of through trains that center on the main line at Anderson. S.

KENOSHA, WIS.—Thomas B. Jeffry has been awarded damages to the amount of $133,000 against the Chicago & Milwaukee Electric Railway Company and the receivers of the company by the Circuit Court of Kenosha County. Jeffry had demanded $2,000,000 as the value of land taken from him by the company as its right of way. In the previous trial, $135,000 of damages were awarded, but the State Supreme Court returned the case for a new trial, holding that the verdict was excessive. The Chicago & Milwaukee Electric

Railway Company's representative, Louis Quarles of Quarles, Spence & Quarles of Milwaukee, moved to have the verdict set aside as excessive. The case will likely be appealed to the Supreme Court. M.

REXBURG, IDAHO—The Idaho Power and Transportation Company, of Idaho Falls, has recently acquired the property of the St. Anthony Light and Power Company, which supplies Sugar City, Rexburg, St. Anthony and Teton. The deal involves $150,000, and the Idaho Power and Transportation Company is to take possession on December 1.

COLUMBIA, WASH.—Plans for branch lines in the Rainier Valley involving approximately $50,000 have been completed by the Seattle, Renton & Southern, and part of the work is now under way. President W. R. Crawford has announced that all of the plans for extensions and branch lines made during the summer will be rushed toward completion.

MEMPHIS, TENN.—The Tennessee Traction Company has been incorporated, with a capital of $50,000, for the purpose of building a line from this city to Nashville by way of Jackson. Officers were chosen as follows: W. K. Burton, president; W. R. Gilbert, vice-president; Horace N. Smith, secretary and treasurer; George E. Bushnell, general manager.

CATSKILL, N. Y.—In pursuance of a judgment of foreclosure and sale granted at a special term of the Supreme Court, John W. Collopy, referee, will sell on behalf of the Hamilton Trust Company as trustee the premises and property in the village of Catskill known as the Catskill Electric Railway Company, at the front door of the courthouse, at Catskill, on the 22d day of December, 1909.

HERRIN, ILL.—Work is soon to begin on an electric interurban line from Murphysboro to Carbondale, with good prospect of extending the line through the coal belt and to the Ohio River, ending at Shawneetown. The line is built by Southern Illinois capital, incorporated as the Murphysboro & Southern Illinois Railroad, which has just put a street-railway system into operation in Murphysboro.

EUREKA, CAL.—George Henderson, who has arrived from San Francisco, has asked the City Council for an electric-railway franchise from the water front through the city, and has asked that the proposed franchise shall require a forfeit of $25,000 and shall provide for the use of the sixty-pound steel rails. He states that the people he represents will erect a power plant for the operation of the road. A.

SALEM, ORE.—The Portland, Eugene & Eastern Railway Company, A. Welch, president and general manager, has a crew of men at work in this city to-day building the first of the two miles of a city system for which it has a franchise, and also the first of an extensive interurban system which is planned to include Salem, Albany, Stayon, Eugene and various other towns and cities in the Willamette Valley.

OGDEN CITY, UTAH—The Salt Lake and Ogden Railway has begun the construction of a power plant at Lagoon, for the electrification of the railway between here and Salt Lake City. The plant at Lagoon will cost $200,000 and substations will be erected at Lagoon, Stockdale, Clearfield and Ogden at a cost of about $25,000 each. Work on the plant is being pushed and cars will be in operation in a short time.

PITTSBURG, PA.—It is stated on good authority that the Baltimore & Ohio Railroad is negotiating for the purchase of the lines of the Grafton Traction Company, a report admitted by some of the representatives of the company. The raliroad is credited with owning a controlling interest in the Fairmont, Clarksburg and Elkins lines which, with the Grafton lines, would give it control of the traction situaton in eastern West Virginia.

CINCINNATI, O.—Articles of incorporation have been drawn up for the Cincinnati-Big Bone Interurban Railway Company, which plans to build a road through Covington, Erlanger, Florence, Union and Big Bone Springs, a distance of twenty-one miles. The incorporators are: Dr. M. J. Crouch, A. W. Koch, J. J. Weaver, J. W. Kennedy, Orlando P. Schmidt, Robert Holmes, Louis Fritz William Riedlin and Joseph Feltman.

CANTON, O.—There is a report to the effect that a merger of the Northern Ohio Traction, Stark Electric and Youngstown & Ohio Electric lines will be brought about shortly and that lines between Salem and Youngstown will be built. A merger of all the traction lines to this section of the state is said to be under way. Traction stockholders and officials of this city are interested in the Canton deal as well as in the purchase and control of other lines near by.

FREMONT, O.—The Fremont-Fostoria Electric Railway Company has acquired possession of the Fremont street-railway line, which connects the city with the village of Ballville on the south. The Fremont-Fostoria line will use the local line for an entrance to the city, enabling the cars of the interurban line to get down to the very heart of the business section. It is expected that the grading of the road will be completed before the first of the year.

ALAMEDA, CAL.—F. P. Fisher has been awarded the contract for finishing the power house of the Southern Pacific Company, now being erected between Park Street and Fruitvale Avenue, Alameda. His bid to finish the plant was $127,000. The power house will supply current for the operation of the passenger system, which is to be made by the Southern Pacific Company by converting its present steam roads in the east bay cities into electric lines.

GUTHRIE, OKLA.—The Citizens' Traction Company of Oklahoma City, which consolidation of the Patterson and Hurst interurban interests, was recently chartered, with $300,000 capital. Lines are proposed from Oklahoma City to Shawnee and Oklahoma City to Sulphur, with a possible extension to Fort Smith, Ark. The directors include Alfred Hare of Shawnee, principal owner of the Shawnee-Tecumseh Interurban; John F. Winans, L. E. Patterson and W. F. Harn of Oklahoma City and H. S. Hurst of Holdenville.

INDIANAPOLIS, IND.—An order has been entered by Judge Vincent Carter in the Superior Court, authorizing the issuance of $460,000 in receiver's certificates for the completion of the Indianapolis, New Castle & Toledo Interurban line from Indianapolis to New Castle. Practically all of those who held claims against the company when the Union Trust Company was appointed receiver have agreed to have the receiver's certificates issued, and it is announced that the work of construction will begin at once.

WALLA WALLA, WASH.—The Northwestern corporation has asked for an extension to its franchise covering electric power, lighting, electric railways and gas. The extension is asked to correspond with the new $5,000,000 bond issue. A. Welsh, general manager of the Northwestern corporation, states that he is considering the construction of electric roads to Wallowa, Ore., and Dayton, Wash. There is a report that the Northwestern corporation is planning to combine with the Washington Traction Company.

CINCINNATI, O.—The Cincinnati, Harrison & Indianapolis Traction Company has been incorporated at the nominal capitalization of $10,000 to construct a traction road over the present tracks of the old Westwood steam railway, through Westwood and Cheviot, and on to Harrison, and eventually through to Indianapolis. A survey had been made as far as Harrison, and preliminary steps have been found favorable to the completion of the project. A. K. Nippert, Chas. E. Roth and Will L. Finch are among those interested in the proposed road.

GREENSBORO, N. C.—Parties identified with the Southern Power Company are reported to be occupied with surveys and obtaining rights-of-way for an interurban trolley system extending from Greensboro, N. C., by way of Salisbury and Charlotte, to Spartansburg and Greenville, S. C. The routes parallel the lines which the Southern Power Company has built for the distribution of its hydroelectric power from its 200,000-horsepower plant. The names of W. S. Lee, Jr., vice-president of the Southern Power Company, of Charlotte, N. C., and of J. B. and B. N. Duke, of the American Tobacco Company, are associated with the project.

## TELEPHONE AND TELEGRAPH.

*(Special Correspondence.)*

ELGIN, TEX.—K. F. Leggett is about to establish an electric-light plant here. P.

CASH, ARK.—The Farmers' Mutual Telephone Company will extend its line to Jonesboro. P.

BUTTE, MONT.—The Montana Independent Telephone Company has been incorporated. P.

CAMP CREEK, S. D.—The Belle-Fourche Telephone Company will install a local exchange. P.

KAUKAUNA, WIS.—The Kaukauna Telephone Company has been incorporated, with a capital stock of $5,000. P.

ST. JOSEPH, MO.—The Home Telephone Company has been incorporated, with a capital stock of $1,200,000. P.

PORT ARTHUR, TEXAS—A new exchange equipped with the latest telephone apparatus has just been completed.

LYONS, NEB.—The Burt County Telephone Company has been incorporated, with a capital stock of $100,000. P.

LEWISVILLE, TEX.—The Lewisville Light and Power Company has been incorporated, with a capital of $2,000. P.

KENNEBECK, S. D.—The Kennebeck Telephone Company has been incorporated, with a capital stock of $5,000. P.

PAXTON, NEB.—The Paxton and Sutherland Telephone Company has been incorporated, with a capital stock of $5,000. P.

CHECOTAH, OKLA.—The Checotah-Texanna Telephone Company has been incorporated, with a capital stock of $4,000. P.

SAN FRANCISCO, CAL.—R. P. Schwerin, general manager of the Pacific Mail Steamship Company, states that the entire

Pacific fleet of the company will be equipped with wireless telegraph apparatus.

SAN ANTONIO, TEX.—The Farmers' Independent Telephone Company is beginning the construetion of rural lines. P.

MADISON, WIS.—The Timber Conlee Co-operative Telephone Company, of Westby, with a capital stock of $680, has filed articles of incorporation. M.

DALLAS, ORE.—The Dallas Telephone Company has been incorporated, with a capital of $25,000, by C. B. Sunderberg, Henry Berning and J. J. Keber.

ROSCOE, TEX.—The Roscoe, Snyder & Pacific Railway Company has let the contract for fifty miles of telephone and telegraph line to Balsh Bros., of Hermleigh, Tex. P.

SANTA ROSA, CAL.—The Petaluma Rural Telephone was recently incorporated, with a capital of $50,000. The lines are to cover the rural districts outside of Petaluma.

PORTLAND, ORE.—The Home Telephone Company will erect three new exchanges on the East Side and will extend its system largely. The cost of the exchanges will be $100,000.

FORSYTH, MONT.—The local telephone company will install important improvements. The central office will be moved to the old Journal building and a new switchboard installed. C.

BUTTE, MONT.—Acting for the Interstate Consolidated Telephone Company, Thaddeus S. Lane bought outright the long-distance lines of the J. S. Haley Telephone Company, of Bozeman. C.

SHERWOOD, N. D.—A company has been organized by farmers in Winlay, Elmors and Workman townships, all in Canada, to build fifty-seven miles of telephone line to connect with the central office here. C.

BUTTE, MONT.—The Independent Telephone lines between Livingstone and Gardner, Bozeman and Salesville, Bozeman and Chimney Rock, and others, have been purchased by the Interstate Consolidated Telephone Company.

LEWISTOWN, ME.—At a recent meeting of the stockholders of the Monroe & Brooks Telephone Company the following officers were elected: President, Fred L. Palmer; vice-president, John Nealley; secretary, Harry Littlefield; treasurer, Joseph Littlefield.

HARRISONBURG, VA.—At a recent meeting of the New Valley Telephone Company the following officers were elected: President, Abram Sanger, Mount Solon; vice-president, Dr. B. H. Beydler, Bridgewater; secretary, L. Z. Miller, Bridgewater; treasurer, George A. Snell, Bridgewater.

HUME, FAUQUIER COUNTY, VA.—The Morven Telephone Company has been chartered by the state, the capital being $500 to $5,000. The incorporators are: James R. Green, president, Markham, Va.; E. Marshall Newton, secretary and treasurer, Hume, Va.; C. H. Corder, Edward Ambler, C. J. Yates, Hume, Va. I.

PORT LAVACA, TEX.—The Port Lavaca Telephone Company, which is owned by W. T. Best and H. C. Ennis, of this place, has selected a route for a new line, which it will build from Port Lavaca to O'Connorport, a distance of twenty-five miles. The line will run by way of Alamo Beach. It is planned to begin the construction work soon. D.

TACOMA, WASH.—The City Council of Tacoma will bring action against the Pacific Telephone and Telegraph Company to ascertain whether the company has a franchise to operate in this city. The franchise of the old Sunset Telephone Company has expired, but the company claims that it was given an extension of franchise until 1915 when it laid wires underground several years ago.

SAN ANTONIO, TEX.—The board of county commissioners of Bexar County has granted the petition of the Farmers' Independent Telephone Company for right-of-way and privilege to construct a rural telephone line through certain parts of this county. John M. Melcher is president of the company; August G. Bippert, secretary, and Emil F. Bippert, treasurer. Its principal office is in San Antonio. D.

AUSTIN, TEX.—At a meeting of the stockholders of the South Texas Telephone Company held here November 1 the following directors were elected: J. A. Quisenberry, of Danville, Ky.; John H. Robinson, Jr., of Austin; J. B. Earle, of Waco, Tex.; S. J. Brooks, of San Antonio, and James W. McClendon, of Austin. The new board elected the following officers: J. A. Quisenberry, president; James H. Robinson, Jr., vice-president; James W. McClendon, secretary; Robert E. Carrington, of Austin, auditor and treasurer, and Robert E. Shelley, of Austin, general manager. This company operates in many counties in South Texas and is doing a profitable business. Important improvements and extensions are under consideration. D.

## ELECTRICAL SECURITIES.

Advance rumors of President Taft's message have had a rather disquieting effect upon the stock market during the past week, although the rumors touch on nothing that has not been publicly expressed by the president. This break in prices is, however, to be expected at the beginning of a new administration. The copper combine is as yet uncertain. Three times the prices have broken, and after the third time Boston, the headquarters of the copper industry, declared that if there had ever been such a thing as a copper combine contemplated the idea had been discouraged by the Standard Oil decision. Nevertheless, there was a rumor in Wall Street that J. P. Morgan & Company is at the head of a combine and believes it can succeed where H. H. Rogers failed. While it is generally believed that if this company is formed it will be so carefully organized as not to conflict with the anti-trust laws, there is no doubt that production will be curtailed to uphold prices. The effect that this will have on the electrical industries is quite apparent.

At the annual meeting of the Continental Telegraph Company directors were re-elected, and subsequently the officers were re-elected.

The November earnings of the Chicago Railways Company show a daily gain of $5,000, with the estimated gross for ten months $10,375,000, or an increase of $1,250,000.

New York Public Service Commissioner Maltbie conducted a hearing last week on the application of the Kings County Electric Light and Power Company for the issuance of $5,000,000 of convertible debenture bonds. Very little was accomplished, as Counsel Searing for the company objected to the statement that was to be filed on the ground that he had not corrected it; but he promised to have everything in presentable shape shortly. The proceedings were adjourned until December 13.

For the year to end with December the New York Telephone Company is expected to earn close to eleven-and-one-half per cent on its $85,672,800 outstanding capital stock, out of which dividends at the rate of six per cent are now being paid. This leaves a balance of rising $4,500,000 to devote to property extensions. It is not at all unlikely that the dividend rate may be increased from six to seven per cent, giving the American Telephone Company, which owns the entire capital stock, an increased return of nearly $900,000. The constituent properties forming the present New York Telephone Company had total assets as of June 30 last of $125,869,014, of which $108,068,087 included real estate and construction.

### DIVIDENDS.

Mackay Companies; quarterly dividend of one-and-one-fourth per cent on the $41,380,400 outstanding common stock, putting this issue on a five per cent annual basis. (The common has been paying four per cent annually since 1906.) The regular one per cent quarterly dividend was also declared on the preferred stock. Both dividends are payable January 3 to stockholders of record December 11.

Massachusetts Electric Companies; semi-annual dividend of one-and-three-fourths per cent, payable January 1.

West End Street Railway Company; regular semi-annual dividend of $2 per share, as rental, payable January 1.

### NEW YORK.

| | Nov. 29. | Nov. 22. |
|---|---|---|
| Allis-Chalmers common | 15 | 15½ |
| Allis-Chalmers preferred | 54¼ | 55 |
| Amalgamated Copper | 86¾ | 99⅜ |
| American Tel. & Cable | *80 | *80 |
| American Tel. & Tel. | 141¼ | 143⅞ |
| Brooklyn Rapid Transit | 77⅝ | 78¼ |
| General Electric | 161 | 163 |
| Interborough-Metropolitan common | 22⅞ | 23⅜ |
| Interborough-Metropolitan preferred | 55⅛ | 55½ |
| Kings County Electric | 129 | 129 |
| Mackay Companies (Postal Telegraph and Cables) common | 92 | 93 |
| Mackay Companies (Postal Telegraph and Cables) preferred | 75¾ | 76 |
| Manhattan Elevated | 138 | 140 |
| Metropolitan Street Railway | 21 | 20 |
| New York & New Jersey Telephone | 123½ | 123½ |
| U. S. Steel common | 88⅛ | 89¾ |
| U. S. Steel preferred | 124 | 125¾ |
| Western Union | 78 | 79½ |
| Westinghouse common | 84¾ | 85¾ |
| Westinghouse preferred | 134 | 135 |

*Last price quoted.

### BOSTON.

| | Nov. 29. | Nov. 22. |
|---|---|---|
| American Tel. & Tel. | 141¼ | 143⅞ |
| Edison Elec. Illuminating | ..... | 259 |
| General Electric | 161 | 163 |
| Massachusetts Electric common | 15¾ | 16 |
| Massachusetts Electric preferred | 78½ | 80 |
| New England Telephone | 134 | 134 |
| Western Tel. & Tel. common | 12 | 12¼ |
| Western Tel. & Tel. preferred | 89 | ..... |

### PHILADLELPHIA.

| | Nov. 29. | Nov. 22. |
|---|---|---|
| American Railways | 45 | 45 |
| Electric Company of America | 12¼ | 12½ |
| Electric Storage Battery common | 58¼ | 58½ |
| Electric Storage Battery preferred | 58¼ | 58½ |
| Philadelphia Electric | 12⅞ | 12¾ |
| Philadelphia Rapid Transit | 26 | 26¼ |
| Philadelphia Traction | 89 | 89 |
| Union Traction | 52 | 52½ |

CHICAGO.

| | Nov. 29. | Nov. 22. |
|---|---|---|
| Chicago Railways, Series 1 | 95 | 98 |
| Chicago Railways, Series 2 | 32 | 33 |
| Chicago Subway | 5½ | 6 |
| Chicago Telephone | 135 | 136 |
| Commonwealth Edison | 118½ | 119 |
| Metropolitan Elevated common | 16½ | 16 |
| Metropolitan Elevated preferred | 52 | 52 |
| National Carbon common | 96½ | 96½ |
| National Carbon preferred | 123 | 123 |

## PERSONAL MENTION.

FRANK CORDTS was recently elected president of the Citizens' Light, Heat and Power Company, of Jersey City, N. J., taking the place of A. J. Volk, who recently resigned.

OLIVER L. TURGEON, well known for a number of years as representative of the Eastern Carbon Company, has left this company to become connected with the sales force of the Stackpole Battery Company, of St. Mary's, Pa.

F. F. ESPENSCHIED has resigned his position with the West Penn Railways Company to assume the management of the Interstate Light and Power Company, at Galena, Ill. Mr. Espenschied has for a number of years been connected with the railway company as consulting engineer to the operating manager, W. E. Moore.

T. COMMERFORD MARTIN, executive secretary of the National Electric Light Association, will be the guest of honor at the next meeting and dinner of the League of Electrical Interests of St. Louis, to be held at the Mercantile Club, December 7. The league membership is made up of men representing all of the different electrical industries of the city.

HARRY SCHLEY SANDERSON, supervisor of city lighting, presented his resignation to the Board of Public Improvements on November 26. It was accepted to take effect on October 31. His successor has not yet been appointed. Mr. Sanderson, who is a grandnephew of Admiral Winfield Scott Schley, has been supervisor of city lighting for the last two years.

CHARLES ROBBINS, who has for many years been connected with the Westinghouse Electric and Manufacturing Company in the industrial and power sales department in connection with the sale of industrial motors, has recently been appointed manager of this department. Mr. Robbins has been with the company since 1899, in which time he has been in the manufacturing department, the New York district office sales department, and for the past three years in the industrial and power sales department at East Pittsburg. His headquarters will continue to be at East Pittsburg.

SAMUEL A. CHASE, who for the past few years has been with the Westinghouse Electric and Manufacturing Company in the New York sales office as a special detail and supply salesman, has recently resigned to accept a position with the White Investing Company, of New York city, a financial investment company handling stock of many different organizations. Previous to Mr. Chase's employment with the Westinghouse Electric and Manufacturing Company he was a salesman for the Western Electric Company, where he was highly successful. Mr. Chase will, after January 1, be in charge of the Chicago office of the White Investing Company, having exclusive territorial rights in North and South Dakota, Minneapolis, Iowa, Illinois and northern Indiana.

## OBITUARY.

ALBERT V. PORTER, who was for many years the consulting architect for the New York City Street Railway Company, died at his home, 267 Madison Street, Brooklyn, last week. He was born in Gloversville, N. Y., fifty-three years ago, and is said to have drawn the plans for the first electric power house built in this country. He was a fellow of the American Institute of Architects. His wife, two sons and two daughters survive him.

HON. FRANCIS H. RAYMOND, treasurer and general manager of the Cambridge Electric Light Company, and formerly representative, senator and member of the governor's council, died recently at his home in Somerville, Mass. Mr. Raymond was operated on last February, and although the operation was successful, the shock proved too great for him. The end came suddenly. Mr. Raymond had attended to business within three weeks of his death, and had been confined to his room only four days. He leaves a widow and a daughter, Miss Alice Raymond, of Somerville, and one son, Edward B. Raymond, general superintendent of the General Electric Company, at Schenectady, N. Y.

JOHN CALDWELL, treasurer of the Westinghouse Airbrake Company, vice-president of the Bank of Pittsburg and a leading financier of Pittsburg, was found dead in his office at Wilmerding shortly before noon on November 23. He had been stricken by heart disease while signing some letters, and fell dead in an effort to reach the door to summon help. Mr. Caldwell was seventy years of age and he had been treasurer of the Westinghouse Airbrake Company for thirty years. He became a director and stockholder of the Merchants and Manufacturers' Bank, Pittsburg, and when this institution was absorbed some years ago by the Bank of Pittsburg, Mr. Caldwell became a director and vice-president in the Bank of Pittsburg.

ROBERT M. VAN ARSDALE, proprietor of *The American Engineering and Railroad Journal*, died suddenly at his home, 276 West Seventy-first Street, on November 23. Apoplexy was given as the cause of death. Mr. Van Arsdale had been working hard for months past, and it is believed that overwork was indirectly the cause of his sudden death. Hardly had he reached his home and taken off his overcoat when he complained of feeling ill. His wife telephoned immediately for a doctor, but before he arrived Mr. Van Arsdale was dead. He is survived only by his widow.

## NEW INDUSTRIAL COMPANIES.

ST. LOUIS, MO.—The Gleeson-Brokaw Electric Company has been incorporated to handle electrical fixtures, etc. P.

ST. LOUIS, MO.—The American Electric Machine and Elevator Company has been incorporated, with a capital of $10,000. P.

PLAINFIELD, N. J.—The United States Electric Smelters, of Newark, N. J., has been incorporated; capital, $150,000. Incorporators: James H. Reid, Edward A. Filkins and Frank E. Gollier.

CLEVELAND, OHIO—The Cleveland Vibrator and Electrical Company has been incorporated, with the following as incorporators: R. Brown, V. G. Murphy, N. A. Quilling, W. H. McJury, B. A. Scott.

FORT WAYNE, IND.—The Electric Supply and Fixtures Company has incorporated, with a capital of $25,000. The company will manufacture all kinds of electrical supplies, equipment, fixtuhes, etc. S. M. Foster, H. L. Sayler and F. H. McCulloch, directors. S.

ALBANY, N. Y.—The Hooker Electro Chemical Company of Niagara Falls, has been incorporated with a capital of $3,750,000. The directors include: Franklin Remington, Michael Gavin, Percy K. Hilton of New York city; George E. Velie and Albert H. Hoower, of Niagara Falls.

CANTON, OHIO—The United Electric Company, of Canton, has been incorporated to take over the holdings of the Power Electric Company, and to enlarge the business of the concern. The new company is backed by the Berger interests with $200,000 capital. The incorporators are Edward A. Langenbach, W. W. Irwin, Harry R. Jones, Charles A. Dillon and Charles L. Goughnour.

## LEGAL NOTES.

REQUIREMENTS IN MAINTAINING TELEPHONE LINES OVER NAVIGABLE STREAMS—The case of Heiberger vs. Missouri & Kansas Telephone Company, 113 Southwestern Reporter, 730, was brought to recover damages for injuries sustained by the plaintiff through a gasoline launch in which she was riding on the Missouri River colliding with a sagging telephone wire. Recognizing such river as a navigable stream, a public highway, which no person or corporation had the right to obstruct, and conceding, for argument, that the telephone company, in maintaining a telephone line which crossed over the highway, was in the exercise of a lawful right, the Kansas Court of Appeals says that the enjoyment of the right carried with it certain duties and responsibilities. Both in the construction and maintenance of its line the defendant was bound to take into consideration the right of the public to navigate the river, and was required by the plainest principles of law, first, to build the line at a height above the water sufficient to permit the free passage under it of river boats, and then to exercise at least reasonable care to prevent it from becoming an obstruction and menace to navigation. Though not an insurer of travelers on the highway against danger of injury from fallen wires, the company owed them the duty above stated, and a negligent breach of such duty would afford a person injured thereby an action for the damages sustained. The presumption of negligence might be overcome by showing that the falling of the wire was not the result of negligence in the construction and maintenance of the line, and that the defendant had neither actual nor implied notice of the fact that it had fallen in time to have removed the obstruction by the exercise of reasonable care.

CONTRACT FOR EXCLUSIVE SERVICE UPHELD—In measuring the effect of an agreement such as one for the installation of a telephone system in a hotel, with a provision that no instruments or wires other than those furnished by the company were to be placed or maintained in said hotel or connected with or maintained in connection with the switchboard apparatus, etc., the Fourth Appellate Division of the Supreme Court of New York says, Central New York Telephone and Telegraph Company vs. Averill and another, that the court is not alone to consider the public, which may be interested only in a theoretical way, but the rights of the parties to the agreement must not be overlooked. The residents of a street or of a village may get

telephone service at a low rate if the use is confined to one company. If there are two or three competing lines, each supplying the residences on the same street and with the same general connections, the added original cost and the expense of operation and maintenance with the division of revenues must eventually increase the charge to the patrons if the companies continue to do business. The customers are the sufferers in the end. The term public is a variable one, and these customers may comprise the public so far as that locality is concerned. The people at large or of the whole village may not be interested in the agreement with the citizens of this street to the extent of securing its abrogation. So far as appeared in this hotel case, only the parties to the agreement were affected by it, and yet, on the pretense that the rights of the public were endangered, the courts were asked to allow the defendants to disclaim liability for their further performance and evade the payment of obligations already incurred in furnishing the service which it entailed. The court thinks there was no necessity for making the public the scapegoat of this plan.

EVIDENCE AND DAMAGES IN SUIT FOR FAILURE TO FURNISH AGREED POWER—The case of Kimball Brothers Company vs. Citizens' Gas and Electric Company, 118 Northwestern Reporter, 891, was brought to recover damages alleged to have been sustained by a failure of the defendant to furnish as agreed an adequate and sufficient electrical current to run an elevator and motor in a certain building. The contract was alleged to have been made while the building was being erected and the installation proceeded with in consequence thereof. But at that time the defendant was furnishing monocyclic current and when it later attached its wires to a motor designed for three-phase operation it was found that it could not start the motor when the elevator was loaded to capacity, and that without the use of a clutch or other device it could not furnish the amount of power required to operate the elevator successfully when fully loaded. Many attempts were made to correct the difficulty, but the defendant did not succeed in making the elevator work until the plant from which it got its current was changed entirely from the monocyclic to the three-phase system. During the time the parties were trying to make the motor work, it was taken to a power plant and given a brake test. This disclosed that the motor was not at fault, and that, when a current of from 200 to 230 volts was supplied to each of its circuits, it would do the work and furnish the necessary power. Bearing in mind that the defendant was claiming that the trouble was with the motor, in that it was not adapted to the monocyclic current, the Supreme Court of Iowa holds that there was no error in giving the results of this test in evidence to the jury. At the same time in view of the issues tendered and of the claimed result of the test, the court thinks that the defendant ought to have been permitted to prove by an electrical engineer the difficulty of using a monocyclic system in connection with a regular three-phase motor to carry a load of 6,000 pounds. Assuming that the defendant did not furnish the kind of current that it agreed to, the court thinks that it was error to instruct the jury that it might allow the plaintiff the difference in the rental value of the building with and without the current agreed upon during the entire time of something like three years until the defendant changed its system. The plaintiff was entitled to this difference only for the time that the defendant was endeavoring to comply with its contract, and for such reasonable time thereafter as would have enabled the plaintiff to have substituted some other known and approved motive power for the running of its elevator. This was the most it would be entitled to under any circumstances. Whether or not it should have supplied the motor with the clutch or other device to enable it to be started before that time was a fair question for a jury. If, in the exercise of reasonable care and prudence at moderate or small expense, it could have remedied the difficulty, it should have taken that course, and, if a jury should find that this was the proper course to have been pursued, the plaintiff would not have been entitled to the rental value of the building after it became its duty to remedy the defect.

COMPANY NOT LIABLE FOR INJURY FROM PULLING APART OF TWO-CLAMP SPLICE OF MESSENGER WIRE BETWEEN POLES—A lineman engaged in attaching the loops or hooks to a messenger wire in the construction of a new telephone line was injured by the cable, on which he was suspended in midair, parting at a splice about halfway between the poles. The only claim of negligence appeared to be that the company had changed the method of splicing from a three-clamp splice to a two-clamp splice, and that it had permitted its foreman to direct that the splice should be made between the poles, instead of at or near a pole, it being claimed that the strain would be greater at the intermediate point than at or near one of the poles. But there was no evidence that the company had provided for making the splice at the particular point. It was engaged in the work of constructing a telephone line. It was necessary, and an incidental part of such construction, that the cable should be spliced at the end of each length of cable, and this lineman himself had helped in making such splices on the very day of the accident, besides the one where he was injured. This work the company had intrusted to a competent foreman, with competent helpers. The fact that the foreman may have erred in judgment in directing the splice to be made midway between the poles, instead of at or near one of the poles, in the absence of evidence that experience had demonstrated the unsafety of such construction, so that the company should have made regulations about it, the Supreme Court of New York, Appellate Division, Second Department, holds, Tweed vs. Hudson River Telephone Company, 114 New York Supplement, 607, did not constitute actionable negligence as against the company. This left the only question of negligence to depend upon the question of whether the company disregarded any duty in changing from the three-clamp splice to the two-clamp splice, and in this regard the evidence failed, the court says, to show that a two-clamp splice, properly made, was not a proper and safe splice, or that it was any less safe than the other one. The jury, however, apparently concluded that the fact that this splice pulled apart and injured the lineman entitled him to recover damages, for there was clearly no point at which the company was shown to have neglected any duty which it owed to him. The law does not make an employer an insurer. It calls upon an employe to use his own intelligence in carrying out the details of the work in which he is engaged; and where the master has supplied all necessary materials and has provided a reasonably safe place in which to perform the duties, there is no liability for the mere error of judgment on the part of a foreman in making suggestions as to a detail of the work, unless the case is brought within the provisions of the employer's liability act. And a safe place in which to perform the services does not require the master to superintend each step of the work of construction, to see that at all times the employe has preserved the conditions of safety.

## INDUSTRIAL ITEMS.

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia, Pa., announces a change in management of its southern sales office. H. H. Seaman, the former manager, having resigned, A. N. Bentley has been appointed to take charge of this office. Mr. Bentley has had a comprehensive storage-battery experience as the engineer of the Cleveland office.

THE POWER EQUIPMENT COMPANY, Fisher Building, Chicago, Ill., has in stock a number of arc lamps, covering a wide range of selections, which it is offering for sale at very low prices. The company will be pleased to send its bargain sheet on alternating and direct-current arc lamps, and also its list of used steam and electrical machinery upon request.

THE ALUMINUM COMPANY OF AMERICA, Pittsburg, Pa., has recently received an order from the Hydroelectric Commission of Ontario for 1,500,000 pounds of aluminum wire. This company has recently declared a 500 per cent dividend on its capital stock of $3,200,000. In 1908 the entire production of the American Aluminum Company, which controls the bauxite beds of Arkansas, Georgia and Alabama, was 8,200,000 pounds.

THE DUPLEX METALS COMPANY, Singer Building, New York, N. Y., is distributing a unique folder entitled, "How to put conductivity on poles out of harm's way." This circular gives a number of good arguments in favor of copper-clad steel trolley wires, claiming that this wire gives the necessary strength and will outwear a much larger copper wire. Actual figures are given to demonstrate the difference in cost between the two.

THE FLINT & WALLING MANUFACTURING CO., of Kendallville, Ind., has recently placed an order with the Allis-Chalmers Company for additional electrical generating unit to take care of the increased demands of its plant. It consists of an 18 and 30 by 42-inch cross-compound heavy-duty non-condensing engine, operating at 150 pounds steam pressure, direct-connected to a 500-kilovolt-ampere, 480-volt, two-phase, sixty-cycle alternator, with exciter and switchboard.

THE PACIFIC ELECTRIC HEATING COMPANY, Ontario, Cal., has distributed the November number of "Hot Points," which is particularly devoted to holiday goods. The cover design of this publication shows the electric flat-iron manufactured by the company wrapped in an attractive package, the latter being supplied to dealers without additional cost. Numerous other suggestions for the Christmas trade are made, which makes this issue of "Hot Points" very valuable at this time.

THE CUTLER-HAMMER MANUFACTURING COMPANY, Milwaukee, Wis., is distributing important information relative to revised navy specifications. These new specifications are known as 17M1 and 17M2 and are for use in all departments of navy yards and stations. 17M1 covers specifications for direct-current electric motors for operating navy yard machinery and supersedes specifications 2M1 issued by the Navy Department, June 1, 1908. 17M2 covers specifications for induction motors for operating navy yard machinery, and supersedes specifications 17M2 issued by the Navy Department October 9, 1908. All 220-volt, direct-current motors and controlling devices for installation in navy yards, and certain 120-volt apparatus for use on shipboard must

conform to new specifications 17M1. All alternating-current motors and controllers for installation in navy yards must conform to new specifications 17M2. Copies of this circular may be had upon request to the company.

THE HOSKINS MANUFACTURING COMPANY, of Detroit, Mich., well-known manufacturer of electric furnaces and pyrometers, has developed an electric toaster as the first of a new line of domestic heating appliances. In an interesting circular on "The Cheerie Toastove," as this toaster is called, the company describes, in an unusually cheerful manner for a booklet of this type, the many uses and advantages of this device, which should aid it materially in finding a ready market in a great many homes.

THE MINNEAPOLIS STEEL AND MACHINERY COMPANY has recently received an order for a Muenzel gas-engine and gas-producer plant from the Dakota Gas, Electric Light and Power Company, of Scotland, S. D. This makes five orders received by the Minneapolis Steel and Machinery Company for these gas engines in the last two weeks, the others being the electric-light plant at Milbank, S. D.; the electric light and power plant at Ipswich, S. D.; the electric-light plant at Carthage, S. D., and the electric-light plant at Tyler, Minn.

THE DUNCAN ELECTRIC MANUFACTURING COMPANY, La Fayette, Ind., reports that the past two weeks are the banner ones of the entire year in the sale of its Model E direct-current watt-hour meters. The sales include a number of the new astatic switchboard meters with removable armature, as well as many of the new portable test meters with fly-back pointers. This company is forging ahead in excellent shape, not only in the way of greatly increasing its sales and patronage, but in the quality and standard of its apparatus.

THE ALLIS-CHALMERS COMPANY has received an order from the Lackawanna Bridge Company for twenty-five 220-volt direct-current type "K" motors, for its Buffalo plant. This follows an order given in August for a 200-kilowatt direct-current engine-type generator and twenty-one motors. Those motors were compound-wound constant speed, and with one exception, geared directly to shears and punches manufactured by the Cleveland Punch and Shear Works. Part of the last order of motors is compound wound and part shunt wound, and most of these will also be geared directly to the machines.

THE CHARLES L. KIEWERT COMPANY, Milwaukee, Wis., has recently published two interesting pamphlets devoted respectively to the Alba flaming arc lamps and the Economy pure carbon arc lamps. The Alba lamp works with alternating current of sixty and twenty-five cycles, and direct current in any voltage. The distinctive feature of the Alba arc lamp is the vertical arrangement of the carbons with a large, highly efficient chemical core. The maximum intensity is within thirty degrees from the horizontal, and the distribution makes the lamp desirable for economical and uniform illumination of large spaces. The Economy lamp operates on direct current and is recommended particularly for small and medium-sized spaces. The high efficiency is obtained principally by the use of a very thin cored carbon which produces a long arc and a high current intensity on the carbon tips. Full information concerning these lamps will be furnished upon request.

THE CENTRAL ELECTRIC COMPANY, Chicago, Ill., is distributing a new circular descriptive of Pittsburg transformers and illustrating the various types from 0.6 kilowatt to 1,000 kilowatts capacity. This circular shows the various methods of winding employed and calls particular attention to the new type of porcelain bushings and insulation used on the primary leads. The company also has ready for distribution copies of its December price and discount list. This has grown to be a sixty-four-page pamphlet, thus showing the great variety of electrical products handled by this well-known company.

THE WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, Pittsburg, Pa., has recently distributed Bulletin No. 1181, devoted to portable direct-current ammeters and voltmeters. These meters, known as type R, include ammeters and voltmeters operating on the D'Arsonval principle with the permanent magnet and moving coil construction. A unique feature of the type R meter is the single air-gap construction. The moving coil is pivoted so that it swings about one side. The other side swings in a semi-circular air gap of the magnetic circuit. The bulletin describes these meters at length and also contains tables of useful data.

THE ELECTRIC CONTROLLER AND MANUFACTURING COMPANY, Cleveland, O., has recently distributed the November issue of its regular monthly publication, entitled "Common Sense." In addition to the regular entertaining reading matter contained in these publications, this number contains a description of its type "Q" magnetic friction brake for use in connection with electrically-driven machinery, such as hoists, cranes, ore and coal handling machinery, and similar apparatus. This type of brake is particularly adapted in cases where frequent stops and reversals are required and where the safety of the crane or other machinery depends upon the brake employed. A circular showing the various applications of this brake is being sent out in connection with "Common Sense."

### DATES AHEAD.

International Independent Telephone Association. Annual convention, Chicago, December 7, 8 and 9.

Chicago Electrical Show, Coliseum, Chicago, January 15 to 29, 1910.

Wisconsin Electrical Association. Annual convention, Milwaukee, Wis., January 19 and 20, 1910.

Toledo Electrical Show, Coliseum, Toledo, Ohio, January 31 February 5, 1910.

San Francisco Electrical Exposition, January 29-February 5, 1910.

Philadelphia Electrical Exposition, Philadelphia, Pa., February 14-26, 1910.

# RECORD OF ELECTRICAL PATENTS.

**Issued (United States Patent Office) November 23, 1909.**

940,654. ART OF NULLIFYING INDUCTIVE DISTURBANCES. William E. Athearn, New York, N. Y., assignor to American Telephone and Telegraph Company. Filed April 29, 1908. The method of arranging for communication, lines employed in inducing neutralizing electromotive-forces in other lines of communication, consists in rendering each of the neutralizing lines electrically continuous independently of its associated neutralizing lines, and providing for the inducing currents a path separate from the neutralizing lines, such path excluding operating currents.

940,655. ELECTRICAL CONDUCTING SYSTEM. William E. Athearn, New York, N. Y., assignor to American Telephone and Telegraph Company. Filed April 29, 1908. The system comprises groups of lines, an induction coil having a primary winding connected to the lines of one group and secondary windings joined to the lines of a second group, and means for preserving the electrical continuity of each line of the primary group independently of the associated lines.

940,658. SYSTEM FOR NULLIFYING INDUCTIVE DISTURBANCES. John A. Barrett, New York, N. Y., assignor to American Telephone and Telegraph Company. Filed April 29, 1908. Signaling conductors are arranged in groups each comprising a number of conductors, and an induction coil having primary and secondary windings is included in different groups and continues the circuit of each conductor independently of the associated conductors.

940,673. TELEPHONE-KEY AND MEANS FOR ACTUATING THE SAME. William Christensen, Belmont, Mass., assignor to American Telephone and Telegraph Company, Boston, Mass. Filed August 26, 1907. In combination with a number of listening keys are means for temporarily locking each key in the listening position. An electromagnetic releasing mechanism is provided for each key, and a contact device is in circuit with all the releasing mechanisms and under the control of the operator.

940,692. TIME-CONTROLLED ALARM MECHANISM. Hilbert W. Howard, Scranton, Pa. Filed January 27, 1906. One of the hands makes successive electrical contacts around the face of the clock.

940,693. TELEPHONE SYSTEM. David S. Hulfish, Chicago, Ill., assignor to McMeen & Miller, Chicago, Ill. Filed December 28, 1906. Each of the call-seeking devices has moving parts adapted to detect a calling line and to stop in registry with the calling line and to identify the calling line to the operator.

940,698. DYNAMO-ELECTRIC MACHINE. Benjamin G. Lamme and Russell S. Feicht, Pittsburg, and George H. Garcelon, Wilkinsburg, Pa., assignors to Westinghouse Electric and Manufacturing Company. Filed September 13, 1905. Comprises a primary core member, windings therefor having different time constants, a relatively rotatable secondary core member, a winding therefor and a resistance in circuit therewith, and an automatically operated means serving to cut one of the primary windings out of circuit and also to remove the resistance from the secondary circuit.

940,734. ELECTROLYTE FOR USE IN ELECTRIC BATTERIES. Wallace J. L. Sandy, London, England. Filed August 22, 1908. The electrolyte is produced by adding to thirty-six fluid ounces of a mixture containing two volumes sulphuric acid, two volumes of hydrochloric acid and one volume of water the following: Thirty-two ounces of bichromate of sodium dissolved in 128 ounces of water and six fluid ounces of a saturated solution of caustic soda.

940,736. VAPOR ELECTRICAL APPARATUS. Harold M. Scheibe, Wilkinsburg, Pa., assignor to Westinghouse Electric and Manufacturing Company. Filed January 21, 1909. A starting or tilting magnet for vapor electric apparatus comprises an actuating coil or coils and an opposing coil which is effective when the apparatus is tilted.

940,746. TELEPHONE SYSTEM. Henry B. Stone, Providence, R. I. Filed April 16, 1909. Means are provided for regulating the inductive effect between the windings of a transformer.

940,747. PHASE ADJUSTMENT. William E. Sumpner, Moseley, near Birmingham, England. Filed December 4, 1907. A condenser is included in the circuit of one of the transformer windings.

940,774. APPARATUS FOR TREATING MOLTEN METALS. Francis S. Adams, Leetonia, Ohio. Filed July 22, 1909. Describes a form of electrode furnace.

940,786. AUTOMATICALLY-OPERATED GATE FOR RAILWAY CROSSINGS. William J. Cook, Denver, Colo. Filed May 4, 1908. A gate is operated by an electric motor the circuit of which is closed and opened by a passing train.

940,787. RAILWAY SIGNALING APPARATUS. William J. Cook, Denver, Colo. Filed August 17, 1908. Describes an automatic electric-lamp signaling system.

940,810. COASTING-RECORD DEVICE. Frank Hedley and James S. Doyle, New York, N. Y. Filed January 18, 1909. A coasting record apparatus for cars, trains or the like, includes recording mechanism, a motor controller and a brake controller, and means controlled conjointly by the controllers for controlling the recording mechanism.

940,821. PROCESS OF TREATING ORES. John R. Parks, Spokane, Wash. Filed November 23, 1906. The process of treating ores consists in intermixing pulverized ore with a sufficient quantity of liquid to make a mobile mixture, passing such mixture through a series of electrolytic pans in tandem, excluding any one of said pans from the series while the other pans continue with the operation.

940,831. ASEPTIC LAMP FOR DENTAL, MEDICAL, OR SURGICAL PURPOSES. David Stern, Cincinnati, Ohio. Filed June 1, 1909. An electric lamp is provided with a suitable casing and extension piece, etc.

940,847. ILLUMINATED SIGN. Frederick Ward, Chicago, Ill. Filed January 7, 1909. A sign-moving mechanism is electrically lighted.

940,850. APPARATUS FOR TESTING FLUIDS. Howard B. Bishop, New York, N. Y., assignor to General Chemical Company, New York, N. Y. Original application filed September 5, 1907. Divided and this application filed July 29, 1909. The apparatus described is used to compare the electrical conductivity of a test specimen of gas with that of a standard specimen.

940,881. AUTOMATIC CIRCUIT-BREAKER. William H. Lawrence and Philip Torchio, New York, N. Y. Filed February 9, 1909. In combination with alternating-current generators operating in parallel and equipped with an external reactance coil on each generator lead, is an overload relay on each lead calibrated to operate at a current in excess of the maximum instantaneous short-circuit current of each generator and its external reactance coil in series and arranged to control automatically a circuit-breaker.

940,910. SAFETY ELECTRICAL CIRCUIT-BREAKER. William F. Wocher, Robert L. Lemon and Louis H. Mortsolf, Indianapolis, Ind. Filed April 25, 1908. Has a grounded wire extending into the housing.

940,972. PROCESS OF MAKING SALTS OF AMMONIA, ESPECIALLY SULPHATE OF AMMONIA. Oliver P. Hurford, Chicago, Ill. Filed December 12, 1908. The process consists in causing nitrogen gas and hydrogen gas to unite under the influence of electric discharges to form ammonia gas in the presence of sulphuric acid, which combines with the ammonia gas to form sulphate of ammonia.

940,994. TELEPHONE SYSTEM. John N. Wallace, La Crosse, Wis., assignor to Vote-Berger Company, La Crosse, Wis. Filed March 22, 1909. A metal-filament lamp is included in the line circuit.

941,002. SAFETY ELECTRICAL CIRCUIT-BREAKER. William F. Wocher, Robert L. Lemon and Louis H. Mortsolf, Indianapolis, Ind. Filed November 30, 1908. Includes an electrical current-conducting circuit, a movable electrical conducting connector for forming the normal circuit, and a movable locking device acting directly with the connector to ground the circuit and also to prevent restoration of the normal circuit when grounded.

941,020. FUSE. Frank G. Jones, Muskegon, Mich. Filed March 11, 1908. The fuse support has near its end an enlargement over which is spun or crimped a ferrule. The fuse wires are connected to the ferrule and are contained in longitudinal channels through the support.

941,032. PROCESS OF MANUFACTURING INSULATORS. Louis McCarthy, Boston, Mass., assignor to the Macallen Company, Boston, Mass. Filed March 6, 1909. The process comprises placing insulating material in plastic state between male and female members and then subjecting the female member to pressure sufficient to shape it while the insulating material is still in plastic state.

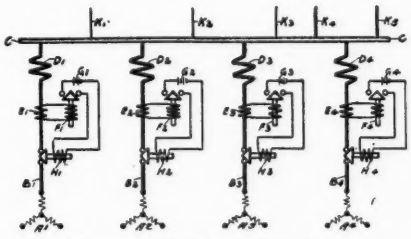
941,086. TELEPHONE ATTACHMENT. Charles B. Mitchell, Franklin, Tex., assignor of one-fourth to Hammet B. Hurt and one-fourth to James W. McCrary, Franklin, Tex. Filed February 19, 1909. Two conducting strips are connected to the two sides of a divided line to constitute the terminals thereof; a contact common to and normally bridging the strips is electrically connected to the speaking circuit; other contacts individual to the strips are electrically connected to the same side of the signal in the signal circuit; and means are provided for moving either strip from the common contact into engagement with its individual contact.

941,113. ELECTRICAL SYSTEM OF DISTRIBUTION. William A. Turbayne, Lancaster, N. Y., assignor to Gould Coupler Company. Filed February 13, 1909. A dynamo-electric machine has an armature core structure provided with two sets of windings, one set being motor windings and the other set being generator windings, and independent field windings are operatively arranged with respect to each of the sets.

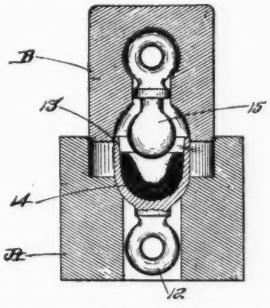
941,114. TELEPHONIC SYSTEM FOR AUDITORIUMS. Kelley M. Turner, New York, N. Y. Filed June 1, 1908. Transmitters are distributed at fixed points with reference to each other throughout a given area; receivers are distributed throughout this area and connected in a single circuit; and a switching station is located in a position which commands a view of the entire area, this station being provided with manually-operated means for connecting any one or more of the transmitters with the circuit containing the receivers.

941,124. IGNITION SYSTEM FOR INTERNAL COMBUSTION ENGINES. Charles B. Askew, Chicago, Ill. Filed November 14, 1907. The engine governor varies the number of battery cells required.

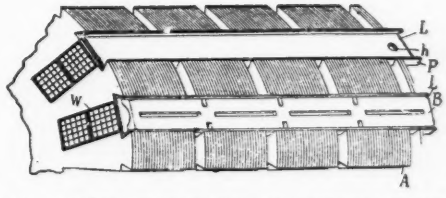
941,144. SIGNAL. Laurence A. Hawkins, Schenectady, N. Y., assignor to General Electric Company. Filed December 29, 1908. Comprises a differential gear, a signal controlled by



940,881.—AUTOMATIC CIRCUIT-BREAKER.



941,032.—PROCESS OF MANUFACTURING INSULATORS.



941,181.—LINING FOR SLOTS OF DYNAMO-ELECTRIC-MACHINE ELEMENTS.

one member of the gear, a pair of electromagnets, and operative connections between the other two members of the gear and the two magnets respectively.

941,151. THIRD-RAIL ELECTRIC-RAILWAY SYSTEM. Charles Kozesnik, New York, N. Y. Original application filed October 30, 1906. Divided and this application filed April 18, 1908. Describes the contact-shoe details.

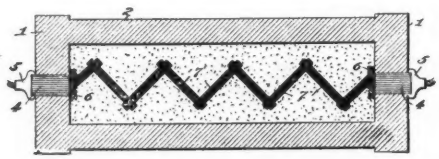
941,157. SPARK-PLUG. Charles A. Martin, Racine, Wis. Filed March 21, 1908. A guard or deflector for a spark plug has an open side and an end piece and is provided with attaching projections, the end piece being in the form of an outwardly extending cone having the apex thereof pointing toward the plug and being planed or cut off to form both a spark orifice and a spark terminal having a thin bordering edge.

941,165. ELECTRIC CUT-OUT. Thomas E. Murray, New York, N. Y. Filed June 18, 1909. A removable circuit-closing plug is adapted to enter between a contact plate and one member of a pair of clip arms.

941,173. ANTISEPTIC MOUTHPIECE FOR TELEPHONES. George Rowlands, Schenectady, N. Y., assignor of one-half to Walter S. Wood, Schenectady, N. Y. Filed June 1, 1909. Has a hygroscopic guard.

941,175. INSULATED RAIL-JOINT. George W. Whiteman, Philadelphia, Pa., assignor to Christian J. Buck, Gallitzin, Pa. Filed March 2, 1909. The walls of the filler bars and splice-bars are recessed and curved to receive insulation between them and the curves of the filler bars.

941,180. BRIDGING-BLOCK FOR DYNAMO-ELECTRIC MACHINES. Frederick W. Young, East Orange, N. J., assignor to Crocker-Wheeler Company, Ampere, N. J. Filed June 2, 1909. An elongated slot-closing bridging block is provided with a forked end.



941,339.—PROCESS OF PRODUCING SILICON CARBIDE.

941,181. LINING FOR SLOTS OF DYNAMO-ELECTRIC-MACHINE ELEMENTS. Frederick W. Young, East Orange, and Edward Heitmann, Montclair, N. J., assignors to Crocker-Wheeler Company, Ampere, N. J. Filed June 5, 1909. An exteriorly insulated metallic trough of high electrical resistance has its sides inclined toward each other, whereby it is constructed to serve as a lining interposed between the walls of a coil-containing slot of a dynamo-electric machine element and a slot-closing bridging-block.

941,182. BRIDGING-BLOCK FOR DYNAMO-ELECTRIC MACHINES. Frederick W. Young, East Orange, N. J., assignor to Crocker-Wheeler Company, Ampere, N. J. Filed July 19, 1909. A slot-closing bridging-block consists of a sheet metal trough and an iron core cast therein.

941,211. APPARATUS FOR PRODUCING AUDIBLE MOVING PICTURES, PIECES OF MUSIC AND OTHER PERFORMANCES. Franz E. Thormeyer, Hamburg, Germany. Filed March 1, 1909. Apparatus for securing synchronous working of two apparatus for producing performances, comprises a driving means for each apparatus, a special independent driving device adapted to control the working of one apparatus and also adapted to be brought into connection with the driving members of the other apparatus.

941,233. AUTOMATIC SAFETY APPLIANCE FOR RAILWAYS. William G. Daring, Pittsburg, Pa., assignor of one-third to Charles B. Henry and one-third to Samuel D. Daniels, Pittsburg, Pa. Filed April 27, 1909. Describes an electric safety signal system for railways.

941,263. RAILWAY SIGNALING SYSTEM. Thomas MacDougal and James M. Chambers, Boulder, Colo., assignors to the Teletopograph Signal Company, Boulder, Colo. Filed June 16, 1908. The signal device is electrically actuated.

941,266. ELECTRIC SWITCH. Waters A. Morse, Westport, N. Y. Filed December 28, 1908. Describes a form of telegraph switch.

941,276. ELECTRICAL RECEPTACLE. Frank J. Russell, New York, N. Y. Filed September 25, 1908. The body has a plug receiving socket, and a wire plug holder having a single spiral holding loop.

941,336. TELEPHONE-CABINET. Charles E. Oxford, Fayetteville, Ark. Filed January 29, 1909. The electrical contacts engage frictionally.

941,339. PROCESS OF PRODUCING SILICON CARBIDE. Frank J. Tone, Niagara Falls, N. Y. Filed June 14, 1907. The process consists in embedding in a charge of silicious and carbonaceous materials a resistance-conductor consisting of a series of separate shaped resistance-pieces of predetermined cross-section and resistance arranged longitudinally in direct electrical contact and supported by the charge, and passing an electric current through the conductor.

941,342. ELECTRICAL SAD-IRON. William A. Braun, Fort Wayne, Ind., assignor of one-half to Fremont L. Jones, Fort Wayne, Ind. Filed January 20, 1908. An expanding member attached to the iron has a movable electric contact in connection with the heating member, with a view to prevent excessive temperature rise.

## PATENTS THAT HAVE EXPIRED.

Following is a list of electrical patents (issued by the United States Patent Office) that expired November 29, 1909:

486,888. ELECTRICAL TRANSMITTING APPARATUS. Albert D. Neal, Boston, and Howard F. Eaton, Cambridge, Mass.

486,902. GALVANIC BODY BATTERY. John W. Shults, Wichita, Kan.

486,909. AUTOMATIC TELEPHONE OR OTHER ELECTRICAL EXCHANGE. Almon B. Strowger, Chicago, Ill.

486,916. ELECTRICAL TRANSFORMER. Elihu Thomson, Swampscott, Mass.

486,926. COIL FOR ELECTRICAL APPARATUS. Henry C. Buck, Somerville, Mass.

486,958. ELECTRIC ARC LAMP. Charles E. Scribner, Chicago, Ill.

486,987. ELECTRIC SWITCH. Wm. J. Schultz, Detroit, Mich.

487,002. SAFETY DEVICE FOR ELECTRIC CIRCUITS. George Cutter, Chicago, Ill.

487,022. ADJUSTABLE ELECTRIC-LIGHT HOLDER. Leroy S. Pfouts, Canton, Ohio.

487,046. ELECTRIC-LIGHT CARBON. James Clegg, London, England.

487,049. INCANDESCENT LAMP. Johannes H. F. Gorges, Berlin, Germany.

487,069. DEVICE FOR TRANSMITTING MOTION FOR ELECTRIC STREET-CAR MOTORS. Walter E. Harrington, Atlantic City, N. J.

487,070. ELECTROMAGNETIC PULLEY. Walter E. Harrington, Atlantic City, N. J.

487,092. ELECTRIC SWITCH. John J. Nate, Chicago, Ill.

487,093. ELECTRIC CURRENT INDICATOR. Chas. P. L. Noxon, Syracuse, N. Y.

487,095. AUXILIARY FIRE-ALARM-SIGNAL APPARATUS. Chas. E. Scribner, Chicago, Ill.

487,096. MULTIPLE-SWITCHBOARD SYSTEM. Chas. E. Scribner, Chicago, Ill.

487,097. TELEPHONE-EXCHANGE SYSTEM. Chas. E. Scribner, Chicago, Ill.

487,098. TELEPHONE-SWITCHBOARD APPARATUS. Chas. E. Scribner, Chicago, Ill.

487,102. DEVELOPMENT AND DISTRIBUTION OF ELECTRICITY. John S. Stone, Boston, Mass.

487,109. AUTOMATIC ELECTRIC-LIGHTING APPARATUS. Leonidas G. Woolley, Grand Rapids, Mich.

487,114. ELECTRIC LOCOMOTIVE. Conrad M. Conradson, Madison, Wis.

487,128. BURGLAR ALARM. Harry W. Reynolds, Long Branch, N. J.

487,154. TELEGRAPHIC APPARATUS. Josiah A. Parker, St. Louis, Mo.

487,176. PROCESS OF ELECTRODEPOSITING ALLOYS. Sherard O. Cowper-Coles, London, England.

487,185. ELECTRIC BELT. John H. Johnson, Dodgeville, Wis.

487,219. TELEPHONE. Hammond V. Hayes, Cambridge, and Wilton L. Richards, Malden, Mass.

487,220. ELECTRODE FOR ARC LAMPS. Chas. W. Hazeltine, St. Louis, Mo.

487,227. ELECTRICAL TYPEWRITER. Albert D. Neal, Boston, and Howard F. Eaton, Quincy, Mass.

487,228. ELECTRIC TYPEWRITER. Albert D. Neal, Boston, and Howard F. Eaton, Quincy, Mass.